

**Recovery of Red Cedar Savanna and Oak Savanna Plant
Communities**

**Report to Pinery Provincial Park & Point Pelée National Park
for the 1999 Field Season**

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Executive Summary

- ❖ Southwestern Ontario is the most densely populated, urbanized, industrialized and intensively farmed part of Canada. The remaining natural habitat cover is 5-10%, and much of this has been subjected to intense human-induced disturbance in the past. Conservation and habitat restoration is, to put it mildly, a huge challenge.
- ❖ This report explains the 1999 fieldwork results of two projects, part of which comprises the research of Cecilia Tagliavia a York University M.Sc. student. The work done at Point Pelée by Ms. Tagliavia, followed up on the M.Sc. research of Nancy Falkenberg.
- ❖ The overall aim of the research was to determine how best to restore Carolinian plant communities, specifically Oak Savanna and Red Cedar Savanna.
- ❖ Both communities are to some degree a fire-dependent. Rare and endangered species (e.g. Wild Lupine and Karner Blue Butterfly) are present and oak savanna itself is considered to be extremely rare in Ontario and globally imperiled.
- ❖ For Oak Savanna communities at Pinery Provincial Park, our goal was to assess the effects of restoration efforts (deer herd reductions and deer exclusion) on plant community composition.
- ❖ Intensive deer herd reductions, and removal of planted pines at Pinery Provincial Park are allowing the Oak Savanna plant communities to move away from the species composition of the early to mid-1990s, towards communities characterized by prairie and savanna species. We support the proposals to continue deer herd reductions and to carry out prescribed burns at Pinery for the foreseeable future.
- ❖ In the future, the recovery rates of these Oak Savanna communities will depend on the presence of a suitable seedbank and the dispersal rates of individual plant species from local seed sources.
- ❖ For Red Cedar Savanna communities at Point Pelée National Park our goal was to assess the effects of restoration efforts (prescribed burns in 1997 and 1999, soil disking and manipulation of red cedar tree densities) on plant community composition.
- ❖ At Point Pelée, there was a significant increase from 1997 to 1999 in the cover of species native to Red Cedar Savanna at one of the two experimental plots (De Laurier), while at the Nature Reserve the cover of native species declined, but this was not significant compared with 1997. Overall, the communities changed in opposite directions at the two experimental sites, most likely because the native seedbank and availability of seed sources varied.
- ❖ We recommend that prescribed burns in Red Cedar Savanna sites be maintained and that desired species be actively reintroduced if no or low levels of local seed sources are available, in order for these species to compete more effectively with non-native species present at these sites.

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Introduction

In this report we have combined the results of the 1999 field season for two related projects, one carried out in Pinery Provincial Park and one in Point Pelee National Park. The two plant communities under study, Red Cedar Savanna and Oak Savanna, have a number of similarities and we judged it to be useful for the different park managers to have some knowledge of restoration and recovery work going on in the other parks.

The Black Oak and Black-White Oak Savannas in Pinery and Red Cedar Savanna in Pelee are all fire-dependent to some degree, and all have been overgrazed by white-tailed deer at some point. Rare and endangered species are present in both communities and the communities themselves are considered to be extremely rare in Southern Ontario (NHIC 1996).

The two Oak Savanna communities are considered by Ontario Ministry of Natural Resources personnel, to be relatively stable and may be successional endpoints (A. Woodliffe, pers. comm., T. Crabe, pers. comm). At Pinery, twenty permanent deer exclosures were built in 1994 in Oak Savanna communities. A herd reduction was undertaken in 1998/1999, and some sites were burned between 1989 and 1993 (T. Crabe pers. comm.). The aim of our research in Pinery was to monitor species composition inside (ungrazed plots) and outside exclosures (grazed plots), with the intent of showing that excluding deer and herd reductions have contributed to the recovery of the Oak Savanna communities.

In contrast to Oak Savanna, the Red Cedar Savanna is considered to be an early successional community that developed in post-agricultural fields. Its decline has been documented both in research reports and by early personal observations by biologists (Geomatix International Inc. 1994). In the report prepared by Geomatix International Inc. (1994) two sites, DeLaurier Field and Nature Reserve, were suggested as being the best candidates for restoration. In 1996 and 1997, Nancy Falkenberg cleared (1996) and burned (spring 1997) these sites (Falkenberg 2000). Two years later, following a second burn (spring 1999), the aim of our research in 1999, was to determine whether there was substantial change in the community composition of the Red Cedar Savanna.

Materials and Methods

Plant community composition: Pinery 1994 and 1999

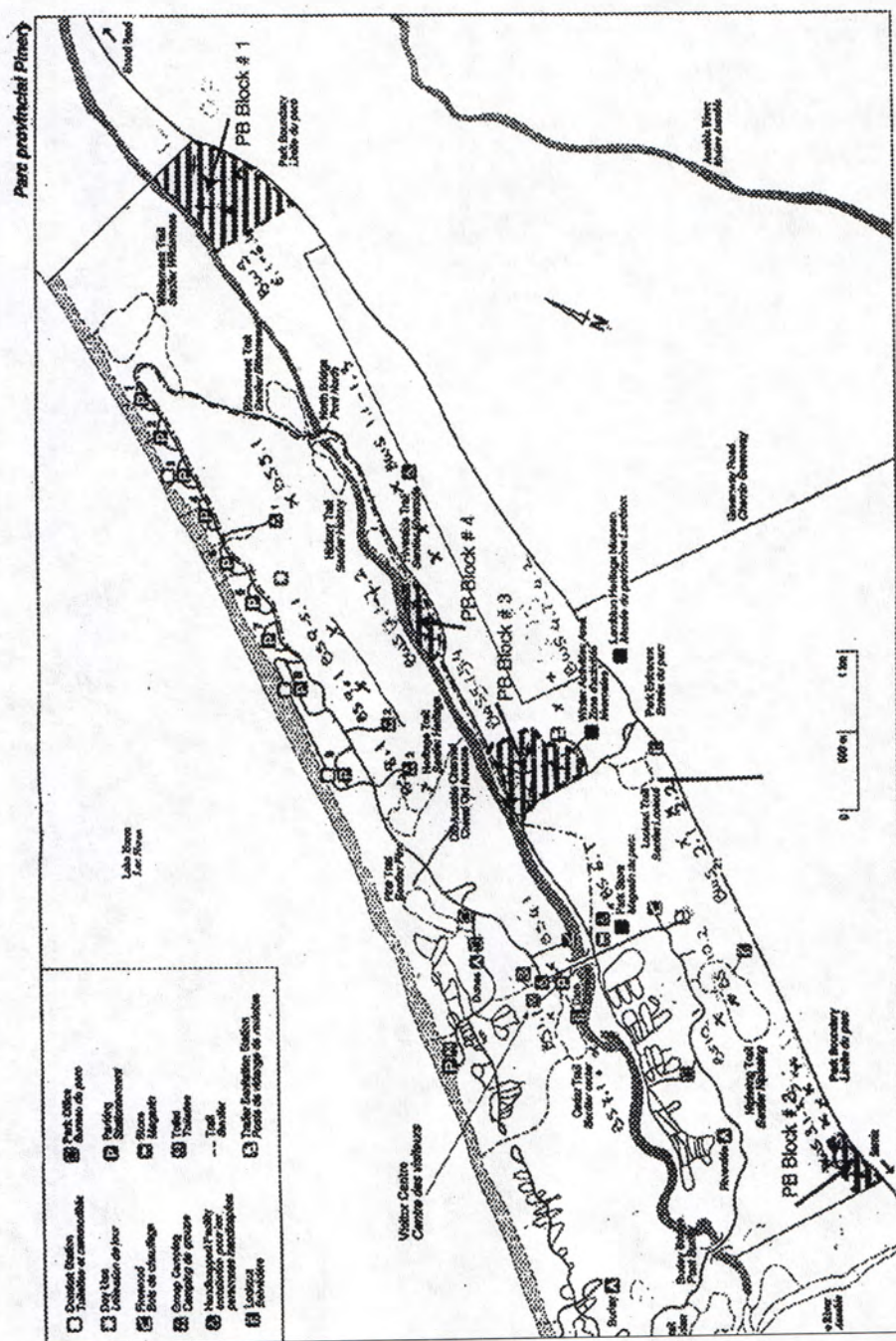
Our first challenge in this research was to find our sites, some of which had not been sampled since 1994. Using directions on record, we found the sites and decided to upgrade the directions (see Appendix 1). Data were collected in grazed and ungrazed plots in 20 sites, 10 in each habitat type, Black Oak Savanna (BS) and Black-white Oak Savanna (BWS) (Map 1). Initial community composition data were collected in July 1994, and then again in July and September 1999.

In 1994 the percentage cover and frequencies of plant species were recorded inside and outside the exclosure within a 1m*1m quadrat. The plant species present in the quadrat inside the exclosure was recorded again in 1999: this quadrat was located in the furthest corner of the exclosure, 10 cm from the fence to avoid edge effects. Unfortunately in 1999 it was impossible to successfully recognize 90% of the grazed, control plots recorded in 1997. These had been marked with bamboo sticks or flagged poles, which had not persisted. Therefore, the day before going out in the field, we generated a list of random numbers which would give us a random direction and point near the NW corner of the exclosure to use for the new control plot location (Tables 1 and 2).

Table 1 Numbers associated with each compass direction.

Compass direction	Number	Compass direction	Number
North (N)	1	South (S)	5
North-east (NE)	2	South-west (SW)	6
East (E)	3	West (W)	7
South-east (SE)	4	North-west(NW)	8

Map 1 Map of Pinery Provincial Park showing location of study plots (see attached powerpoint slide if viewing this as an e-document)



Pinery Prescribed Burn 2000

Table 2 Randomly generated directions to the controls for each site (BS = Black Oak Savanna, BWS= Black – White Oak Savanna). The two sides of the quadrat were placed in specific directions.

Exclosure	Direction	Side of the quadrat	Exclosure	Side of the quadrat	Direction
<i>BS 4.1</i>	6	SW and SE	<i>BWS 1.2</i>	SE and NE	1
<i>BS 1.1</i>	5		<i>BWS 1.1</i>	NW and SE	4
<i>BS 5.1</i>	8	NW and SW	<i>BWS 1.3</i>	NE and NW	6
<i>BS 6.1</i>	2	SE and N	<i>BWS 2.1</i>	W and S	5
<i>BS 7.1</i>	8	N and W	<i>BWS 2.2</i>	NW and SW	7
<i>BS 8.1</i>	3		<i>BWS 3.1</i>		7
<i>BS 9.1</i>	4	SW and SE	<i>BWS 3.2</i>	N and W	2
<i>BS 9.5</i>	3		<i>BWS 3.3</i>		8
<i>BS 10.1</i>	4	NE and SE	<i>BWS 4.1</i>		6
<i>BS 10.2</i>	7	N and W	<i>BWS 4.2</i>		4

Each exclosure was marked at the NW corner with an orange flag. The control quadrat was then placed 3 m from NW corner of the exclosure (or otherwise indicated in the exclosure direction in Appendix 1) and the control itself was marked with an orange flag.

Statistical analysis

Our initial intent was to use the vegetation data from both July and September sample dates in 1999 but because the 1994 data were collected only in July, we restricted our analysis to the summer data. Data were analyzed using a multivariate ordination analysis with the computer program, Canoco (Cornell Ecology Programmes, Koh *et al.*, 1996). Detrended Correspondence Analysis (DCA) was carried on 1994 and 1999 summer species composition.

Plant community composition: Point Pelee 1997 and 1999

The restoration procedures were applied in both DeLaurier Field and Nature Reserve sites (see Falkenberg 2000) (Map 2). In 1996 at each site a 60m*60m plot was

laid out which was sub-divided into four 30m * 30m plots, designated by their location as NE, NW, SE and SW of the area. The entire site was cleared of brush and shrubs, although red cedar trees were left standing.

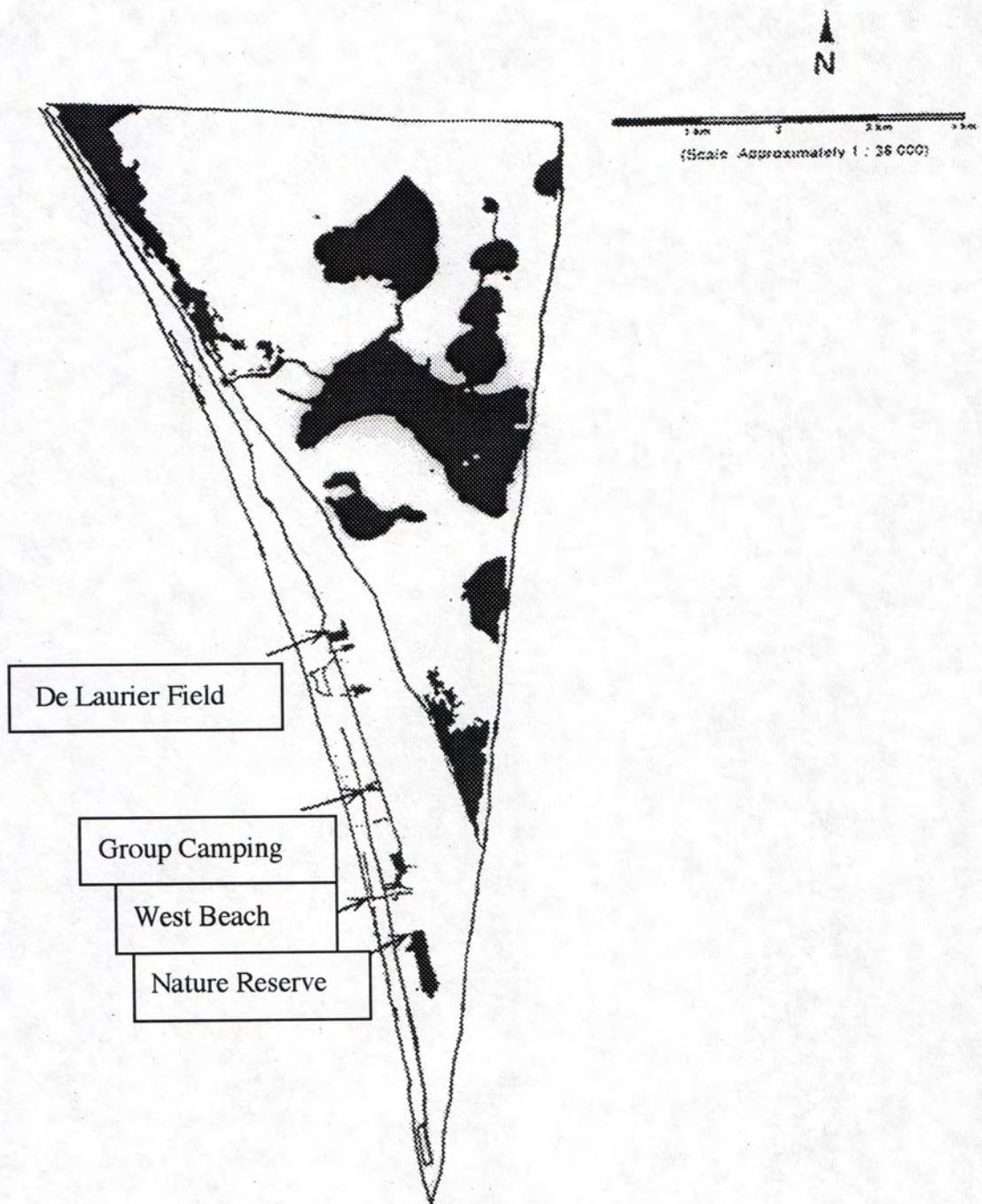
Different treatment combinations were applied in each of the four sub-plots: 1) burning in order to promote seed germination, 2) low or high Red Cedar density in order to register some effect of shadow and 3) disking which would help seeds located in depth to germinate. Specific treatments at the Nature Reserve site were as follows: the NE plot was not burned and a lower density of Red Cedar trees (n=23) was created; the SE plot was not burned and had a higher density of Red Cedar trees (n=45); the SW was burned and had a higher density of Red Cedar trees (n=53); the NW was burned and a lower density of Red Cedar tree (n=19) was created (Fig. 1). In the DeLaurier Field site, the NE plot was burned and a low density of Red cedar (n=3) was created; the SE plot was burned and had a higher density of Red Cedar (n=10); the NW plot was not burned and had a higher density of Red Cedar (n=11); the SW plot was not burned and a low density of Red Cedar was created (n=6) (Fig. 1).

The disking treatment was applied to eight 2m*2m quadrats in each sub-plot. Each disked plot had an adjacent undisked control plot. During the 1997 data collection 16, 1*1m, quadrats in each sector were sampled, 8 of which (the 50%) had the disking procedure applied.

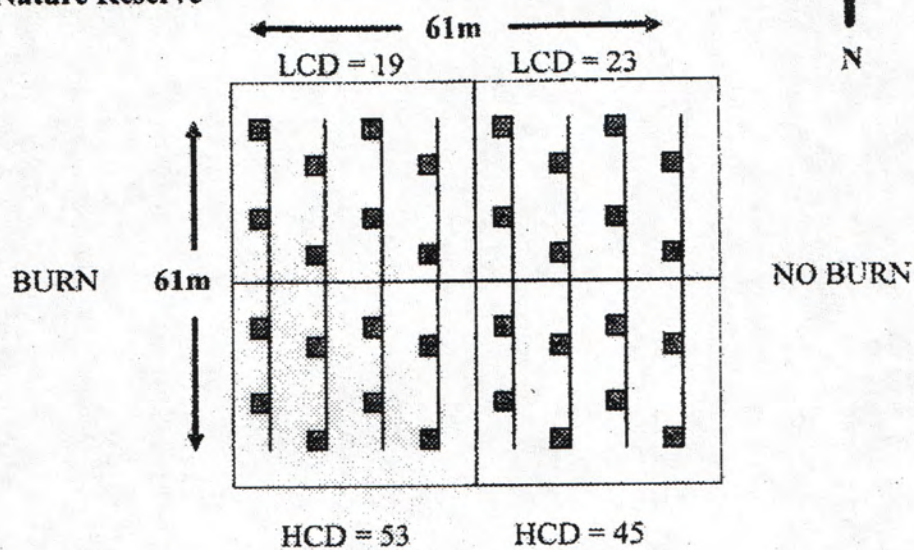
In 1999 the data collection could not be carried out in exactly the same way due to problems with the description of the methodology supplied by N. Falkenberg (this was subsequently addressed). Four parallel transects were laid out from the south side to the north side of the entire 60m*60m plot rather than the 8 transects laid out by Falkenberg. Along these transects 16, 2*2m, quadrats were sampled, 8 of which could be recognized as disked (**Map. 2** and **Fig. 1**). It is important to note that the undisked quadrats sampled were randomly sited along the transect and not contiguous, as they appear in Fig. 1.

Map 2 Map of Point Pelee National Park (see attached powerpoint slide if viewing this as an e-document)

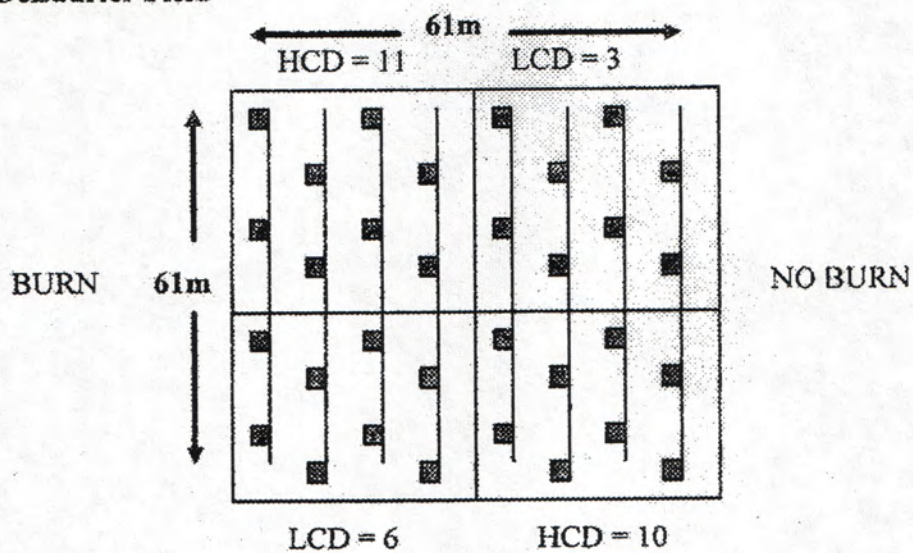
Fig. 1 Experimental design for prescribed burn and cedar removal in Nature Reserve and DeLaurier Field restoration sites (Point Pelee National Park) 1997-1999 (see attached powerpoint slide if viewing this as an e-document)



Nature Reserve



DeLaurier Field



■ = 1m x 1m monitored quadrats
 LCD = low cedar density
 HCD = high cedar density

Statistical data analysis

Because of the difference in data collection between 1997 and 1999 we addressed this as follows: 1) four quadrats of 1m^2 area (in 1997) were pooled in order to correspond with one 2m^2 quadrat (in 1999). 2) In order to obtain the same total number of samples, two 2m^2 quadrats (in 1999) were pooled, all of which corresponded for the different treatments applied. The pooled data consisted of the results of the averaging of the percentage cover for the original data and the sum of the frequency for the original data.

Plant species present were categorized as native or exotic in relation to their presence in the typical Red Cedar Savanna community. The same was done in terms of whether a species was exotic or native to the province of Ontario. Another grouping was done before determining the percentage of exotic species: two groups of data, which corresponded to quadrats where the same restoration treatments were applied, were pooled by calculating the average of number of exotic and number of native species present. This averaged value was considered the value of exotic and native species in 1997 and 1999 data. The percentage of exotic species out of the total number of species present was determined. A nested ANOVA was performed on the arcsine-transformed percentage cover data. Data have been transformed by the following the formula (Harold Zar, 1996):

$$\text{Arcsine } (\# \text{ ex} / \# \text{ tot})$$

where,

ex: number of exotic species in one quadrat

tot: total number of species present in the quadrat

In order to determine the effect of each nested treatment we calculated their F values and compared them with the F-table values. In our experimental design the disking treatment was nested into the density treatment and the density into the burn treatment therefore, the F-values for each treatment was calculated as follow:

$$F (\text{year effect}) = \text{MS year} / \text{MS burn}$$

$$F (\text{burn effect}) = \text{MS burn} / \text{MS density}$$

$$F (\text{density effect}) = \text{MS density} / \text{MS disking}$$

F (disking effect) = MS diskings / MS error,

where,

MS: mean square values determined with the Nested Anova analysis.

A DCA was also carried out for both the Nature Reserve and DeLaurier Field data in order to identify the species that were representative of the plant community in general in 1997 and in 1999.

Tree and shrub density in Pinery Provincial Park

A survey of the woody vegetation was carried out in 1999 at all of the Oak Savanna exclosures ($n=20$). The NW corner of the exclosure was chosen as the center of two intersecting transects that were established along the South-North and West-East directions. The segment from the center to north was 20 m long as well as the one from the center to south. The segment from the center to west was 10 m long as well as the one from the center to East. A flag was used to temporarily mark the location reached and the nearest tree and shrub to the flag was identified. A tree was defined as a woody stem with a diameter > 7.5 cm measured at 1.4 m height above the ground. A shrub was defined as a woody stem taller 0.4 m, with a diameter < 7.5 cm measured at 0.4 m above the ground. The individuals who did not fit in both of these categories were designated as a shrub or tree after calculating the mean of their respective diameters at 0.4 and 1.4 m. This mean was used to place them in one of the categories (tree or shrub).

From the closest tree (or shrub), we moved to the nearest tree (or shrub) and from this to a third tree (or shrub), in each of the four directions (N, E, S, W). We measured the distance between each pair and the Diameter at Breast Height (DBH) of each individual. Therefore in each site we measured a total of 12 trees and 12 shrubs.

The tree and shrub density was calculated as follows:

$$D \text{ (\# of individuals/ha)} = 10,000 \text{ m}^2 (1.67 \cdot d^2)$$

D : absolute density

d : mean distance between nearest neighbor's individuals in a site,

1.67: correction factor (Mueller-Dombois *et al.* 1974)

The Relative species density was determined as follows:

$$RD = \# \text{ ind. sp.} / \text{tot} \# \text{ inds,}$$

where,

ind sp: number of individuals of one species sampled in a site

tot # inds: total number of individuals of all species sampled in a site

The average diameter of individuals of the same species in a site was also calculated.

Statistical Analysis

The tree and shrub density data sets were best tested as a doubly multivariate Repeated measures ANOVA (RMD). The between-subject factor (habitat) is divided into two groups (BS and BWS), and a within-subject factor (time) has two levels, 1994 and 1999. The tree/shrub data set is a case of balanced model (10 samples for each habitat). I used a significance level $\alpha = 0.05$. For each data set three hypotheses are tested:

- 1 Ho: there is no difference in tree/shrub density between BS and BWS ($\mu_{bs} = \mu_{bws}$), Ha: there is a difference.
- 2 Ho: There is no difference in tree/shrub density among time treatment, Ha: There is a difference
- 3 Ho: there is no interaction between habitat (BS and BWS) and time, Ha: there is an interaction.

Plant community composition

Fig. 2 DCA of species cover data from Black Oak Savanna sites in 1994 and 1999. Smaller black circles and numbers represent species. Sites are represented by big circles

and are labelled with the following: PN: Pinery; B; Black Oak Savanna; #: site number; E: enclosure. C: control; 4: year 1994; 9: year 1999. The 1999 sites are also distinguished from 1994 by the gray color of the label.

The solution file in Table 3 allows the reader to link each number and its corresponding species. The species are listed in alphabetical order, and the first four letters are first ones of the genus while the last four are the first ones of the species.

Table 3 Solution file of the DCA performed on the Black Oak savanna data set.

DETR-SEGME	DCA	Rescaling:	4	Segments:	26	Threshold:
No transformation		Scaling:	-1			
Spec: Species scores						
		Axes 1	Axes 2	Axes 3	Axes 4	Weight
	Eigenvalue	0.758	0.3977	0.2522	0.1851	
Number	Species Name					
1	AQUI CANA	4.9799	2.5674	1.2126	-0.2595	15.9
2	CARE PENS	2.9593	2.747	1.3019	0.8578	493
3	CORN RUGO	3.6674	3.9012	-0.1116	5.2199	1
4	CORN SPEC	-0.5629	2.3458	2.5777	2.1337	23.2
5	EUPH ESUL	0.5016	1.9045	3.2423	0.8291	3.5
6	FRAG VIRG	1.7524	2.1233	-0.4234	-0.1005	6
7	FRAG SPEC	0.4572	1.2757	-0.1591	-0.0691	13.4
8	GALI CIRC	-0.5154	2.5748	0.7468	-0.4639	1.8
9	GALI PILO	1.8644	3.055	1.9256	-0.2686	15.8
10	GAUL HISP	-0.1844	1.84	2.8078	-0.4353	3.9
11	GAUL PROC	0.5079	1.0436	4.2197	0.4346	0.2
12	GERA MACU	2.4754	1.4928	0.2468	1.8683	1.4
13	GRAM INAC	0.1172	2.5767	1.3022	0.7452	1240.15
14	HELI DIVA	1.3107	4.3927	2.6203	0.7821	70
15	HELI SPEC	0.5079	1.0436	4.2197	0.4346	4.2
16	HIER SPEC	-0.1031	3.4679	2.4077	-0.2377	1.6
17	IMPA SPEC	0.4675	1.4288	3.8414	0.5488	3.3
18	JUNI COMM	5.0285	2.418	1.0964	1.1189	10
19	JUNI VIRG	5.0285	2.418	1.0964	1.1189	3
20	LITH CANE	4.1019	4.5454	1.5174	-1.1087	1.9
21	LONI SPEC	1.8716	3.7488	1.4847	3.1771	5
23	MAIA CANA	1.7276	2.1097	-0.6123	-0.224	11.85
24	MARR VULG	2.5485	4.3147	1.6505	3.277	2
25	MELA LINE	1.4128	1.7736	2.8374	1.5824	7
27	ORYZ SPEC	3.8966	4.6125	2.658	-1.5508	3
28	PEDI CANA	5.0285	2.418	1.0964	1.1189	4
30	POA PRAT	3.6153	4.4382	0.6989	1.5333	54.4
31	POLY POLY	3.6674	3.9012	-0.1116	5.2199	1

32	PRUN VULG	0.3348	4.2896	2.5558	0.8944	0.5
33	PRUN SERO	2.5345	2.966	1.2027	-0.3769	9.9
34	PRUN SPEC	-0.6501	2.6962	-0.1606	-0.3492	15.4
35	PRUN VIRG	2.3304	4.285	2.3389	-0.4204	17.8
36	PTER AQU	1.766	3.5339	1.7734	2.35	145.5
37	QUER ALBA	3.8639	1.7734	2.0808	2.1909	12.9
38	QUER MUEH	0.4634	4.2123	0.6987	-0.1738	0.5
39	QUER PRIN	2.4047	5.38	2.2823	-0.3682	20.5
40	QUER RUBR	2.8751	4.25	1.0874	-0.9488	1.9
41	QUER SPEC	-0.5285	2.6702	0.7919	-0.398	0.5
42	QUER VELU	1.4492	2.3196	0.244	1.1014	3.25
43	RHUS AROM	2.6934	-0.2807	2.1072	1.5484	84
44	RHUS RAD	1.8039	2.5876	0.1966	2.0515	68.2
45	RUBU OCC	2.8497	1.8821	1.0168	2.1109	24.9
46	RUBU SPEC	0.1301	1.1749	0.3549	0.2853	10.5
47	RUBU IDAE	-0.5176	2.5722	0.7023	-0.45	0.2
48	RUBU SPEC	-0.4085	1.8381	2.9592	2.4423	25.9
49	RUDB HIR	-0.5625	2.668	1.7553	1.8247	1.8
50	RUME SPEC	1.1992	3.2797	3.1608	2.0908	6.4
51	SENE OBOV	2.8913	4.5793	2.6482	-1.4354	23
52	SENE PAUP	1.4806	0.9498	3.1532	0.5227	42.7
53	SMIL RACE	1.8643	3.7686	0.0713	3.7943	1
54	SYMP ALBU	2.0229	2.8176	3.0731	0.8621	21.8
55	TARA SPEC	0.6846	4.176	-0.0245	2.7815	0.4
56	UVUL PERF	1.8199	3.1049	3.456	1.7006	0.9
57	VACC SPEC	1.0209	1.9952	-0.6682	0.2554	82.3
58	VINC MINO	0.1825	1.4402	3.6187	-0.1236	1.8
59	VIOL SPEC	-0.5364	2.6368	1.0031	1.815	4.3
60	VITI SPEC	1.7558	1.7873	0.0279	2.2025	1.1
61	VITI RIPA	3.6674	3.9012	-0.1116	5.2199	0.4
62	UNKN OWNS	2.6349	4.3369	1.4652	2.5675	29.5
63	UNKN HERB	-0.5487	2.1755	2.799	2.2756	10.6
64	UNKN WOOD	-0.0039	3.8231	1.9693	0.0539	0.5

The species that characterize both the control and exclosure data in 1999 were: *Aquilegia canadensis*, *Geranium maculatum*, *Juniperus* sp., *Polygala polygama*, and *Rubus occidentalis*. In 1994 the community was dominated by: *Cornus* sp., *Fragaria* sp., members of the Gramineae, *Prunus* sp. *Rubus* sp. *Viola* sp. In 1994 it was not possible to identify many plants to species level because they were so heavily overgrazed. Both control and exclosure plots at the same site seem to have moved in the same direction in terms of their plant community composition. In 1994 the sites look more clustered together and each control plot had almost the identical composition when compared with the corresponding exclosure. In 1999 the exclosures and their

corresponding control plots are spatially more distant, which means that they have developed a small difference in plant community composition over the intervening 5 years of excluding deer.

A detrended correspondent analysis, DCA, of the Black-White Oak savanna percent cover data (1994 and 1999) was performed for all plots (Fig. 3).

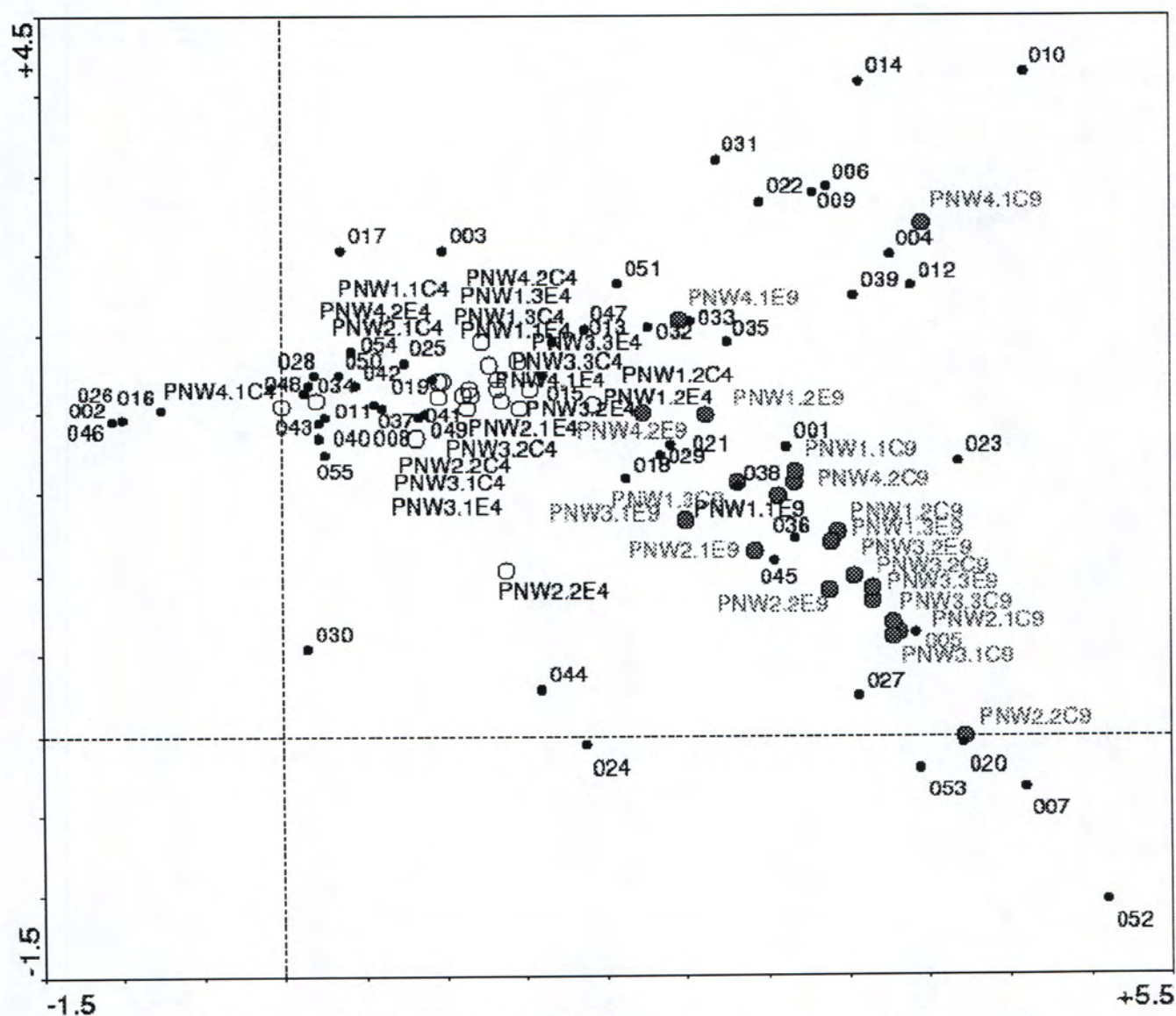


Fig. 3 DCA of species cover of Black-White Oak savanna sites in 1994 and 1999. Smaller black circles and numbers represent species (see solution file below for legend). The sites are represented by big circles and are labelled with the following: PN: Pinery;

W; Black-White Oak Savanna; #: site number; E: enclosure. C: control; 4: year 1994; 9: year 1999. The 1994 sites are white circles and 1999 sites are grey circles.

The solution file for the DCA of Black-White Oak Savanna is shown in Table 4.

Table 4 Solution file of the DCA performed on the Black –White Oak savanna data set.

DETR-SEGME	DCA	Rescaling:	4	Segments:	26	Threshold:
No transformation		Scaling:	-1			
Spec: Species scores						
		Axes 1	Axes 2	Axes 3	Axes 4	Weight
	Eigenvalues	0.7139	0.4586	0.3178	0.2225	
Number	Species Name					
1	AMEL SPEC	3.1233	1.8041	1.9146	-0.1596	12
2	AQUI CANA	-0.985	1.9737	1.1898	1.0496	8.6
3	ASTE SPEC	0.9891	3.0224	0.7049	2.4494	5
4	BLEP HIRS	3.7577	3.0031	5.1343	0.1197	0.5
5	CARE PENS	3.9143	0.6501	1.4942	0.9222	471
6	COMP OSIT	3.371	3.4235	1.8217	-0.7219	2.9
7	CORN ALTE	4.5952	-0.3125	0.4974	0.0739	1.5
8	EUPH ESUL	0.6168	2.0439	0.1256	-0.092	7.7
9	FRAG VESC	3.2837	3.3991	2.9664	-0.7487	0.9
10	FRAG VIRG	4.5937	4.1487	1.0221	1.1423	31
11	FRAG SPEC	0.2565	1.9812	0.4409	2.2267	8
12	FRAX AMER	3.9006	2.8044	0.9923	-0.2977	2
13	GALI CIRC	1.6704	2.4664	2.7413	2.646	5
14	GALI PILO	3.581	4.0846	1.5183	0.5778	28.1
15	GALI TRIF	1.6106	2.2577	-0.199	3.0734	3.1
16	GAUL HISP	-0.7391	2.0384	1.9012	1.3771	0.2
17	GAUL PROC	0.3653	3.0269	2.5565	1.8957	2
18	GERA NMAC	2.1285	1.5972	0.5748	0.9239	12.2
19	GRAM INAC	0.9288	2.23	1.7899	1.4824	622.19
20	HAMA VIRG	4.2061	-0.041	1.2941	1.0747	5.2
21	HELI DIVA	2.4064	1.8176	3.4825	0.2245	221.4
22	HIER SPEC	2.9656	3.3315	0.9147	-0.8913	2.2
23	LESP HIRT	4.185	1.7208	3.7402	3.2284	2
24	MAIA CANA	1.871	-0.051	-0.7941	-1.0369	35.7
25	MELA LINE	0.7421	2.3394	-0.0206	-0.3855	31.9
26	PEDI CANA	-0.9871	1.9731	1.1849	1.0468	14.8
27	POA PRAT	3.5709	0.2485	2.4348	-0.5254	17.4
28	PRUN VULG	0.195	2.2493	1.5455	1.5633	9.4
29	PRUN SERO	2.3445	1.7527	1.5894	0.7995	60.7
30	PRUN SPEC	0.1519	0.5466	-0.4637	-0.7323	13.8
31	PRUN VIRG	2.686	3.5955	1.2186	1.256	29.9
32	PTER AQUI	2.2652	2.5415	3.1745	0.5715	86.5
33	QUER ALBA	2.5364	2.5909	-0.2718	3.2139	51.3
34	QUER RUBR	0.1661	2.1939	3.9094	2.3084	1.2
35	QUER SPEC	2.7514	2.4534	0.66	-0.3492	0.5

36	QUER VELU	3.1677	1.2325	1.6997	-0.3272	20.9
37	RHUS AROM	0.5608	2.0637	2.8339	1.4623	83
38	RHUS RAD	2.8173	1.5479	1.3126	1.4317	50.1
39	RUBU OCCI	3.5427	2.7501	2.852	0.4232	4.4
40	RUBU SPEC	0.2277	1.8521	1.5084	1.3696	37.4
41	RUBU SPEC	0.8821	1.999	4.3818	2.344	8
42	RUME SPEC	0.4574	2.1906	1.4816	2.3232	12.9
43	SANI MARI	0.2308	1.9374	0.3156	0.6658	7.7
44	SASS ALBI	1.6002	0.2885	-0.2934	-0.6477	6.8
45	SENE SPEC	3.0389	1.0932	-1.2155	4.3333	4
46	SENE OBOV	-1.0501	1.9566	1.0482	0.961	1
47	SENE PAUP	1.8762	2.5376	1.7536	0.0325	8.1
48	SMIL RACE	0.1418	2.1467	3.4646	1.6355	0.95
49	SOLI SPEC	0.8448	1.9824	3.8473	2.2828	11.7
50	TARA SPEC	0.3447	2.2659	1.2686	1.3605	0.3
51	VACC SPEC	2.0839	2.8221	0.7915	2.5262	37.8
52	VITI SPEC	5.1029	-1.0304	1.22	1.0219	21.3
53	UNKN OWNS	3.9408	-0.2011	-0.0073	3.2583	33
54	UNKN HERB	0.4233	2.3995	3.0998	2.0436	2.5
55	UNKN WOOD	0.2632	1.7538	0.0948	1.2332	6.6

The species that characterize both the 1999 control and exclosure data are: *Amelanchier* sp. *Carex pensylvanica*, *Hamamelis virginiana*, *Helianthus divaricatus*, *Poa pratensis*, *Quercus alba*, *Q. velutina*, *Rhus radicans*, *Rubus idaeus*, *Senecio* sp. This contrasts with the 1994 plant community, which was dominated by: *Aquilegia canadensis*, *Euphorbia esula*, *Gaultheria hispidula*, *Melampyrum lineare*, *Pedicularis canadensis*, *Prunella vulgaris*, *Sanicula marylandica*, *Rhus aromatica*, and *Senecio obovatus*. We see that the 1994 sites are closer together, which means that they are more homogeneous in their plant community composition, while in 1999 we see that the sites have spread out. Sites such as BWS 3.1, 1.3, 4.1 and 2.2 seem to have become more different from the controls while other sites such as BWS 3.2, 3.3 and 1.1 show that both the exclosure and control (grazed) plot have changed in the same way. Thus, they are closer in the DCA diagram.

Tree and shrub density

We compared the mean tree density of the Black Oak and Black-White Oak Savanna (BS and BWS respectively) sites in 1994 and 1999 (Fig. 4). The mean density did not change significantly over the five years ($p>0.05$). There was also no significant effect of habitat or interaction ($p>0.05$) (Tables 5 and 6).

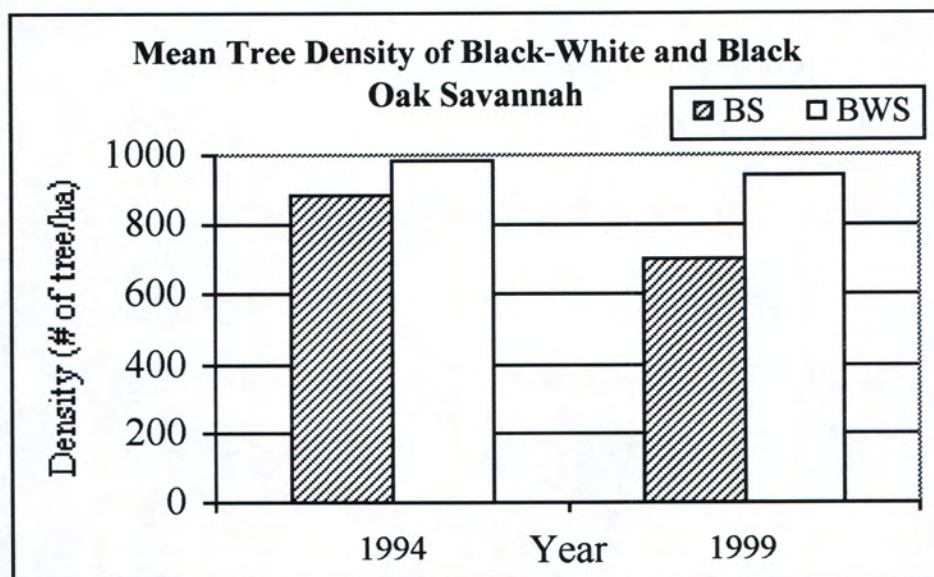


Fig. 4 Mean tree density in BS and BWS sites in 1994 and 1999

In Fig. 5 we can see that plots BS 7.1 and BS 9-5.1 have experienced a large decrease in tree density, while plots BS 1.1, 5.1 and 10.1 showed a moderate increase. In the BWS (Fig. 6) there is an increase of almost 2 times in density in the BWS 1.1 plot and a more moderate decrease in the BWS 1.2 and 2.1.

Table 5 ANOVA table for tree density in BS and BWS sites: time and time x habitat effects.

Tests of Within-Subjects Effects

Measure: TDENSITY

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power ^a
TIME	Sphericity Assumed	133749.225	1	133749.225	1.410	.251	1.410	.203
	Greenhouse-Geisser	133749.225	1.000	133749.225	1.410	.251	1.410	.203
	Huynh-Feldt	133749.225	1.000	133749.225	1.410	.251	1.410	.203
	Lower-bound	133749.225	1.000	133749.225	1.410	.251	1.410	.203
TIME * HABITAT	Sphericity Assumed	52200.625	1	52200.625	.550	.468	.550	.108
	Greenhouse-Geisser	52200.625	1.000	52200.625	.550	.468	.550	.108
	Huynh-Feldt	52200.625	1.000	52200.625	.550	.468	.550	.108
	Lower-bound	52200.625	1.000	52200.625	.550	.468	.550	.108
Error(TIME)	Sphericity Assumed	1707651.650	18	94869.536				
	Greenhouse-Geisser	1707651.650	18.000	94869.536				
	Huynh-Feldt	1707651.650	18.000	94869.536				
	Lower-bound	1707651.650	18.000	94869.536				

a. Computed using alpha = .05

Table 6 ANOVA table for tree density in BS and BWS sites: habitat effect.

Tests of Between-Subjects Effects

Measure: TDENSITY

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power ^a
Intercept	30826580.6	1	30826580.62	135.272	.000	135.272	1.000
HABITAT	287133.025	1	287133.025	1.260	.276	1.260	.186
Error	4101935.850	18	227885.325				

a. Computed using alpha = .05

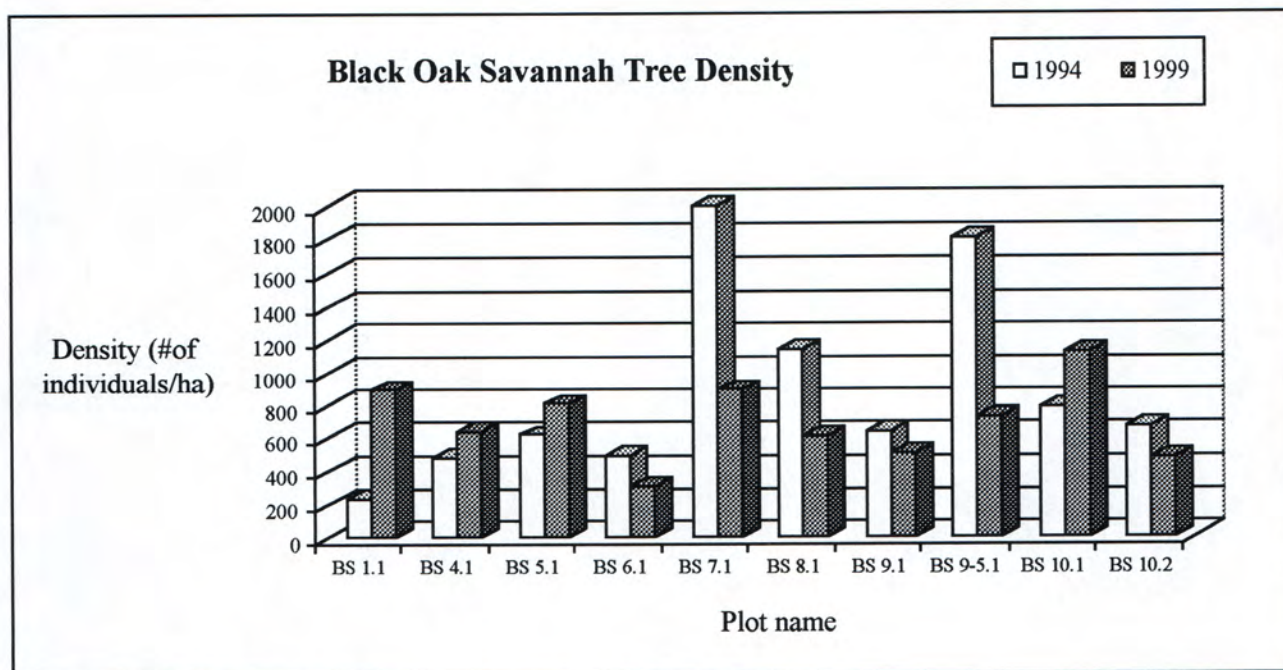


Fig. 5 Black Oak Savanna tree density in 1994 and 1999.

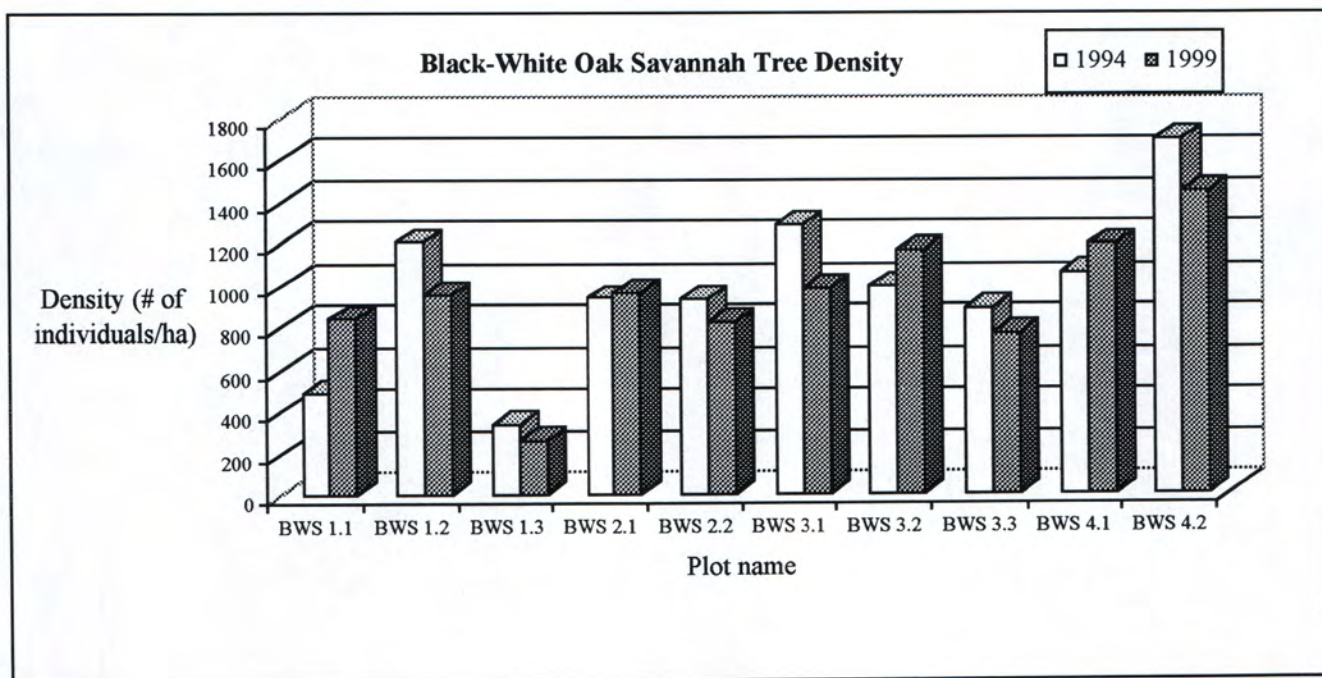


Fig. 6 Black-White Oak Savanna tree density in 1994 and 1999.

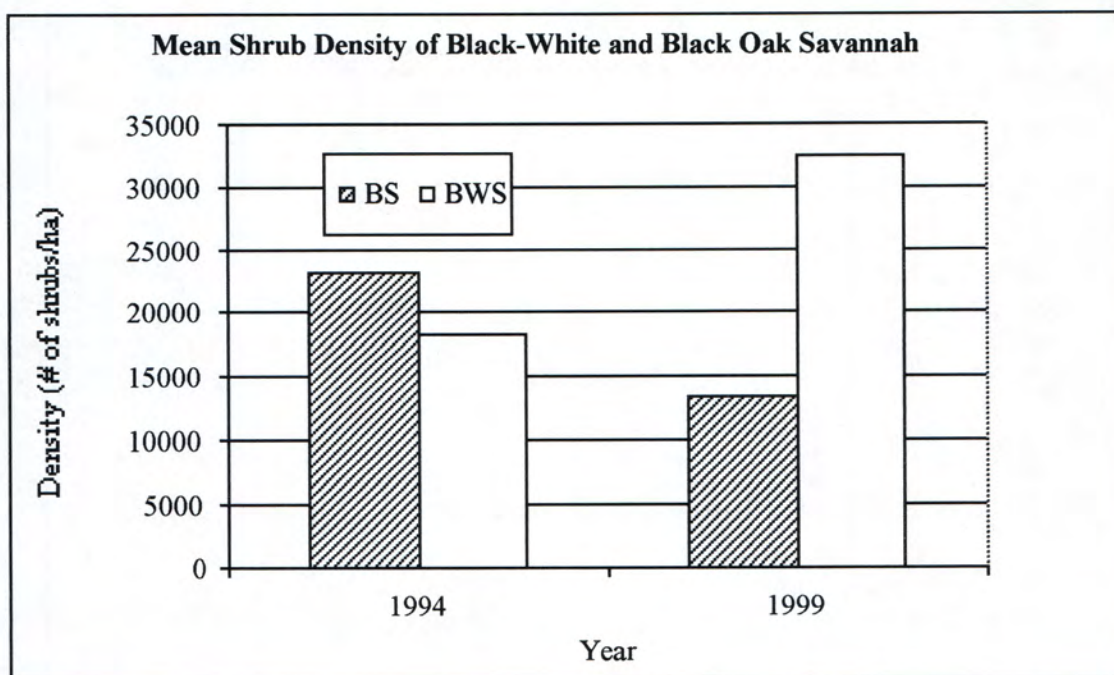


Fig. 7 Mean shrub density in BS and BWS habitat during 1994 and 1999.

Next, we looked at the mean shrub density (Fig. 7), and we observed a consistent decrease in density in the Black Oak savanna, and a near doubling of density in the Black-White oak savanna from 1994 to 1999. In 1994 the BS had a greater shrub density than BWS but in 1999 the situation was reversed. There was a significant interaction (time*habitat) effect ($p < 0.05$) (Tables 7 and 8). The plots that lost more shrubs were BS 1.1, 7.1, 9.1, 9-5.1 (Fig. 8).

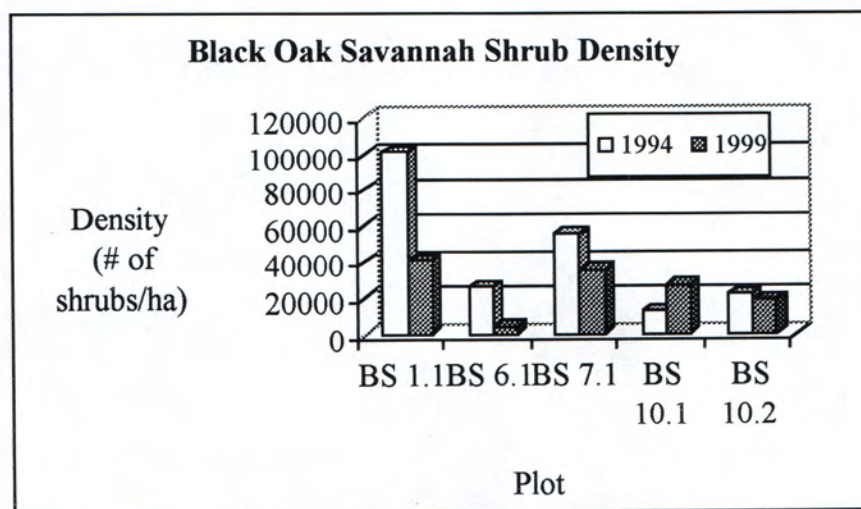


Fig. 8a Black Oak Savannah shrub density in 1994 and 1999 (five plots).

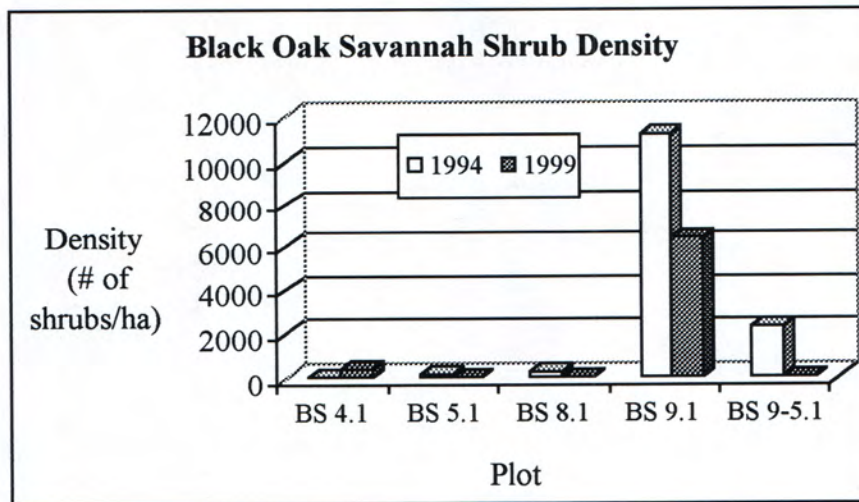


Fig. 8b Black Oak Savanna shrub density in 1994 and 1999 (other five plots)

The shrub density was very low at around 10 individuals/ha in areas where plots BS 4.1, 5.1, 8.1 and 9-5.1 were located.

Table 7 ANOVA table for shrub density in BS and BWS sites: time and time x habitat effects

Tests of Within-Subjects Effects

Measure: SDENSITY		Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power ^a
TIME	Sphericity Assumed	46643040.9	1	46643040.90	.211	.651	.211	.072
	Greenhouse-Geisser	46643040.9	1.000	46643040.90	.211	.651	.211	.072
	Huynh-Feldt	46643040.9	1.000	46643040.90	.211	.651	.211	.072
	Lower-bound	46643040.9	1.000	46643040.90	.211	.651	.211	.072
TIME * HABITAT	Sphericity Assumed	1442473061	1	1442473061	6.529	.020	6.529	.676
	Greenhouse-Geisser	1442473061	1.000	1442473061	6.529	.020	6.529	.676
	Huynh-Feldt	1442473061	1.000	1442473061	6.529	.020	6.529	.676
	Lower-bound	1442473061	1.000	1442473061	6.529	.020	6.529	.676
Error(TIME)	Sphericity Assumed	3976659784	18	220925543.6				
	Greenhouse-Geisser	3976659784	18.000	220925543.6				
	Huynh-Feldt	3976659784	18.000	220925543.6				
	Lower-bound	3976659784	18.000	220925543.6				

^a. Computed using alpha = .05

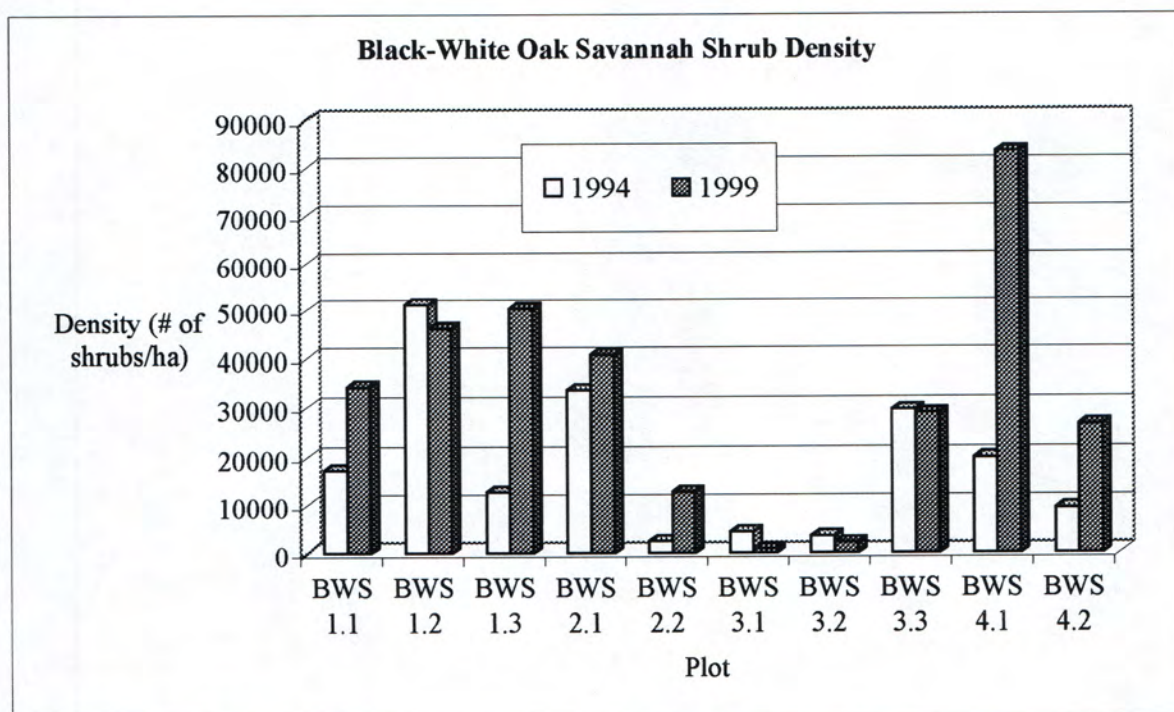


Fig. 9 Black-White Oak Savanna shrub density in 1994 and 1999

Fig. 9 shows the plot-level shrub densities at the BWS plots. Only BWS 1.2, 3.1, 3.2 showed a decrease while BWS 3.3 seemed unchanged. Shrub density in all other increased.

Table 8 ANOVA table for shrub density in BS and BWS sites: habitat effects

Tests of Between-Subjects Effects

Measure: SDFENSITY

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent Parameter	Observed Power ^a
Intercept	1.902E+10	1	1.902E+10	22.143	.000	22.143	.993
HABITAT	515394768	1	515394768.1	.600	.449	.600	.114
Error	1.546E+10	18	859073613.7				

^a Computed using alpha = .05

The following histogram shows the mean diameter for trees and shrubs of the BS and BWS sites in 1994 and 1999 (Fig. 10). Shrub mean diameter in BS and BWS did not change between 1994 and 1999. A very small increase in tree mean diameter seemed to occur in both BS and BWS from 1994 to 1999. Overall shrub diameter was greater in the BS plots than the BWS plots.

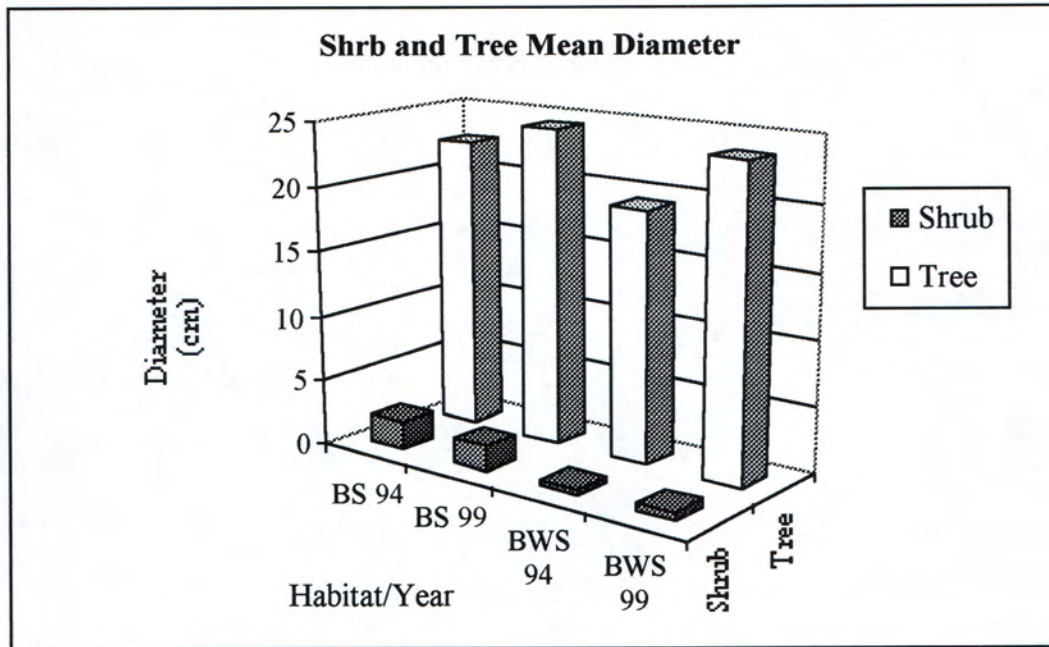


Fig. 10 Mean tree and shrub diameter in BS and BWS sites in 1994 and 1999.

Relative Species Density

We investigated the relative tree density for each species (Fig. 11). In five years, there was an increase in *Quercus velutina* and *Prunus serotina*, while *Pinus resinosa*, *Juniper virginiana* and *Quercus rubra* were better represented in 1994.

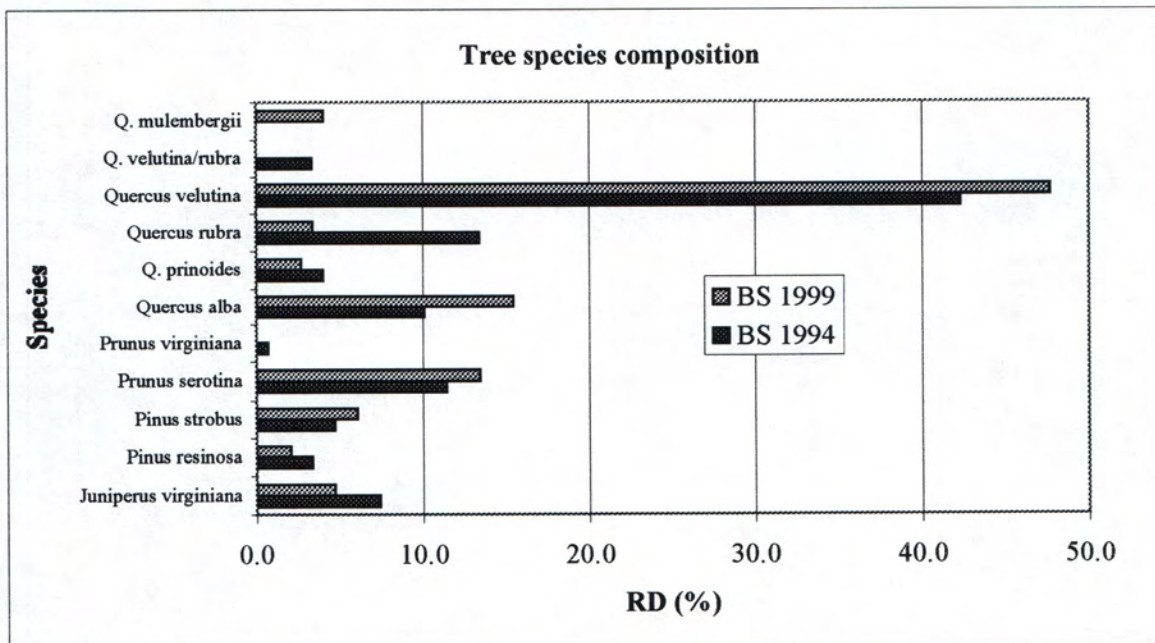


Fig. 11 Relative mean tree (RD) density in BS sites in 1994 and 1999.

The relative shrub density histogram (Fig. 12) shows a decrease of *Quercus prinoides*, *Q. velutina*, *Pinus strobus* and especially *Prunus virginiana* in 1999. In 1999 we found a large increase of *Rhus aromatica*. Some species were present in 1999 and absent in 1994 (e. g. *Amelanchier* sp.).

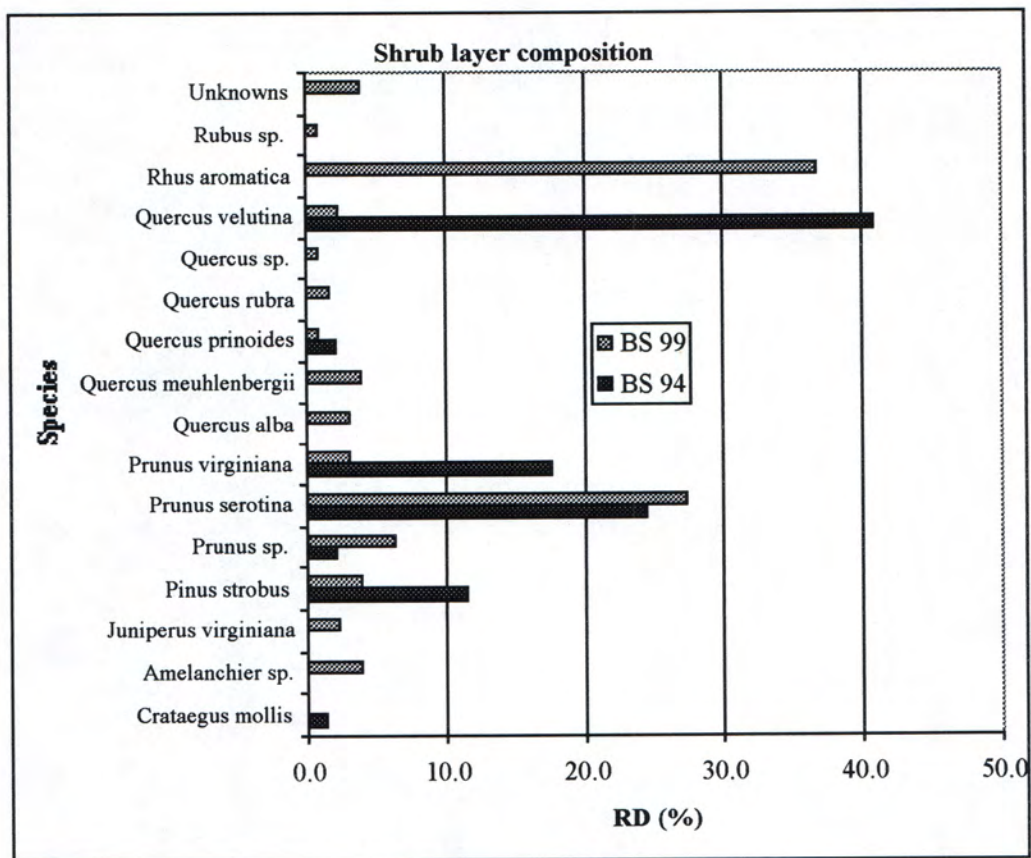


Fig. 12 Mean Relative Shrub Density in BS sites in 1994 and 1999

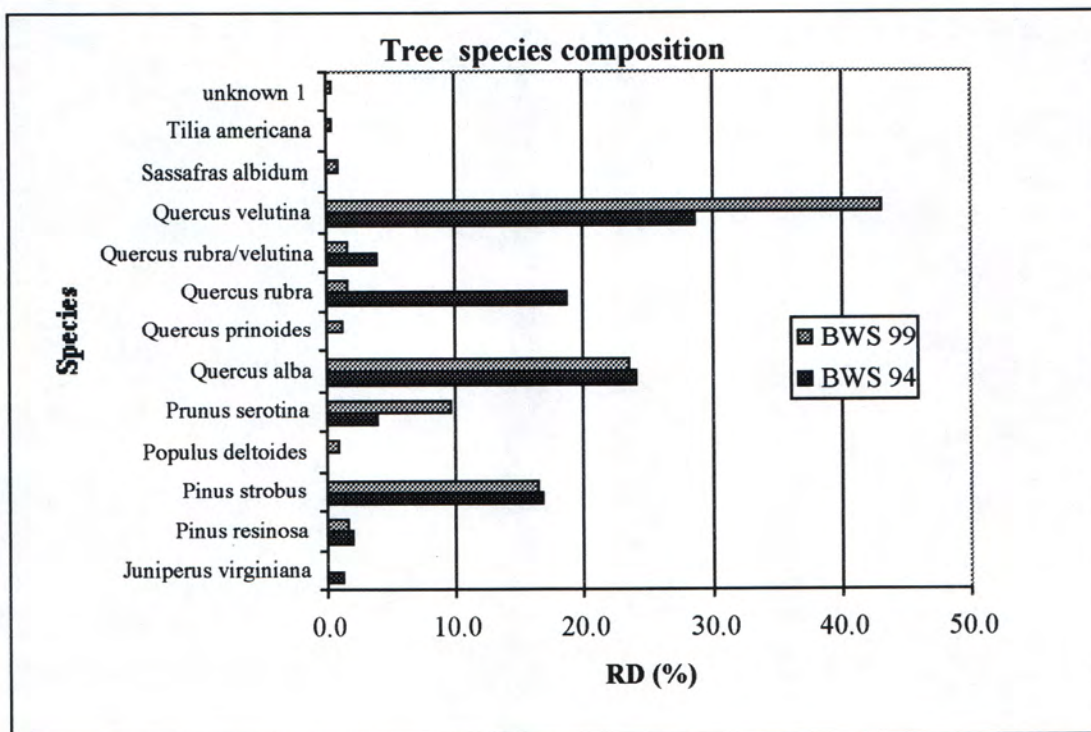


Fig. 13 Mean Relative Tree Density in BWS sites in 1994 and 1999

The relative tree density of the species present in the BWS sites is shown in Fig. 13, showing an increase of *Quercus velutina*, *Q. alba* and *Prunus serotina*. *Sassafras albidum* is now present in the sampled area compared with 1994. *Q. rubra* seems to have decreased greatly in density. *Pinus strobus* is at the same density in 1994 and 1999.

The mean relative shrub density data are shown in Fig. 14. *Prunus serotina*, *Quercus rubra* and *Sassafras albidum* decreased greatly in density. *Rhus aromatica* and especially *Prunus virginiana* also decreased in density. *Amelanchier humilis* was not found in 1999 while *Ribes cynosbati* and *Pinus strobus* and *Quercus velutina* appear only in the later sample.

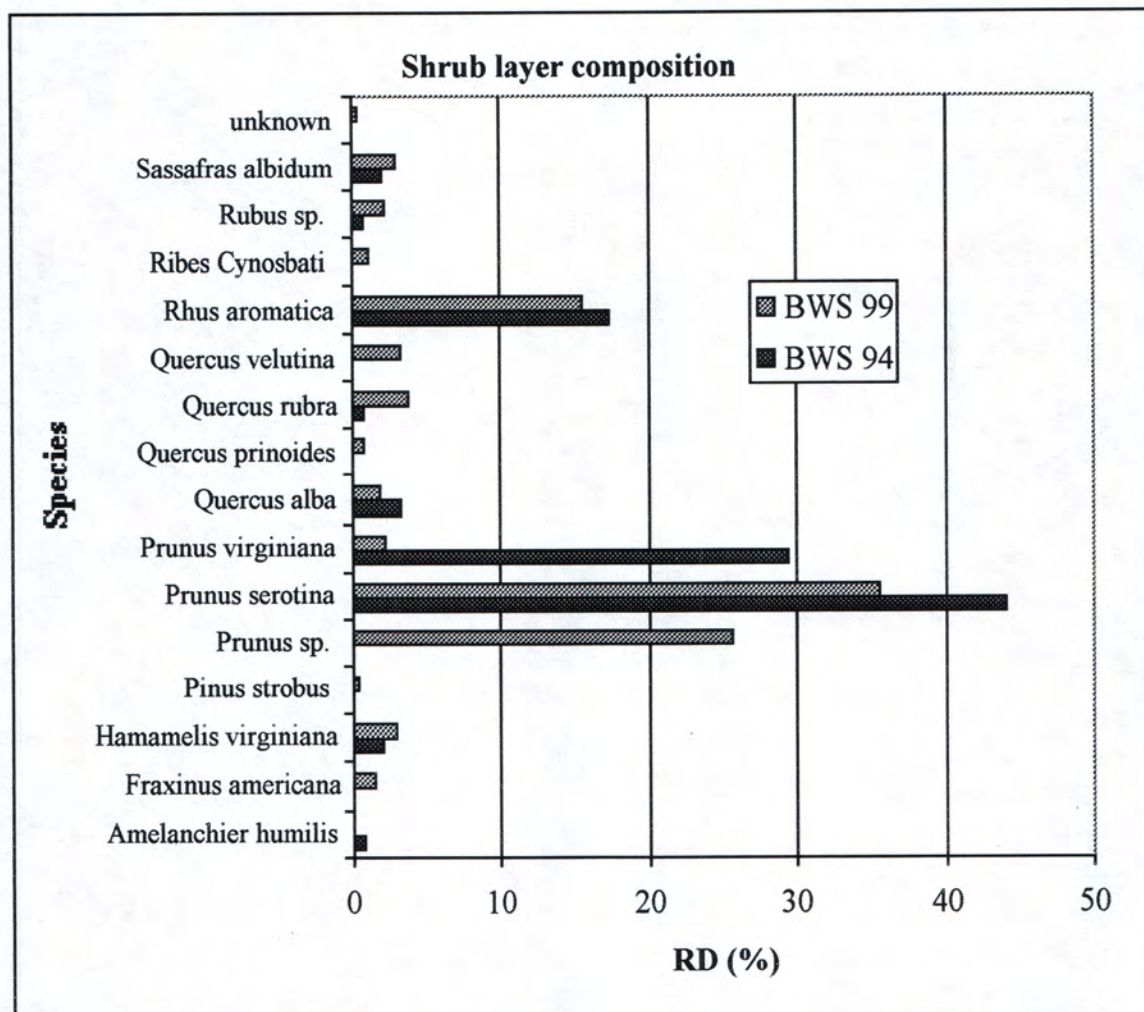


Fig. 14 Mean Relative Shrub Density in BWS sites in 1994 and 1999.

Point Pelée National Park

The experimental plots are differentiated by the labels corresponding to the different treatments (in the same order as they were nested in the experimental design): burn, Red Cedar Density and then Disking (Table 9).

Table 9 Experimental Treatments.

Treatment	Fire	Density	Disking
Label	B: Burn	HD: High (Red Cedar) Density	D: Disking
Label	NB: No Burn	LD: Low (Red Cedar) Density	C: Control (no Disking)

DeLaurier Field

Species identified were categorized as exotic or native to RCS community and to the province of Ontario. We compared the number of exotic species (%) present in the understorey plant community in 1997 with 1999 (Fig. 15). In 1999 following the treatments we observed an increase in the number of species exotic to Ontario, in almost all plots. In the BLDD plots the number of exotic more than doubled. In NBHDC, and NBHDD, we observed fewer exotic species in 1999. In the exotic to RCS savanna, but native to Ontario category there was an overall decrease in the percentage of exotic species.

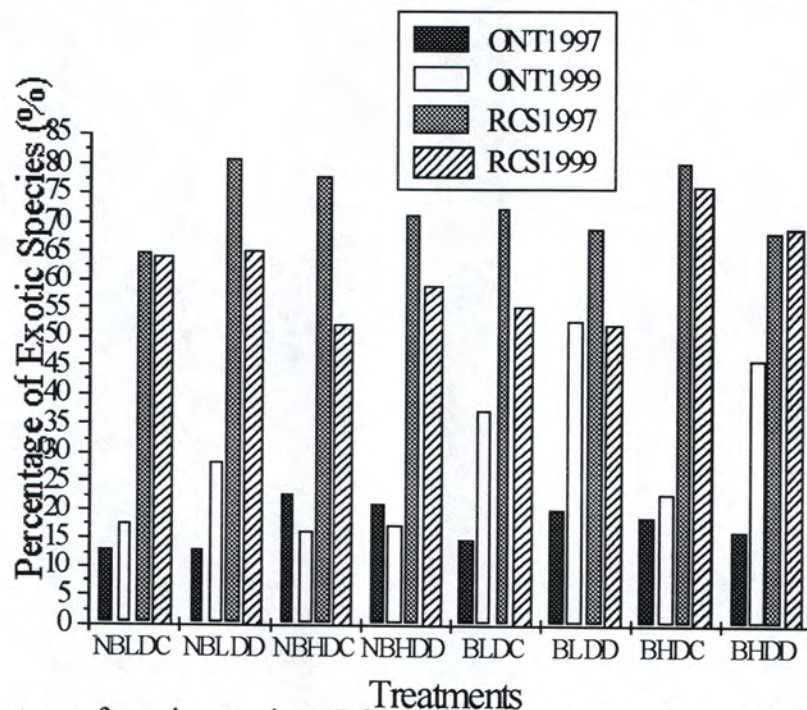


Fig. 15 Percentage of species exotic to RCS and to Ontario in 1997 and 1999 in the De Laurier Field restoration site

The nested ANOVA for the De Laurier Field data set (Table 10) revealed that only time had a statistically significant effect. Overall, the number of species exotic to the RCS community was significantly lower in 1999 compared with 1997. There was no significant treatment effect on the number of species exotic to RCS and to ONT.

Table 10 De Laurier Field. ANOVA on the percentage of species exotic to Ontario (ONT) and red cedar savanna (RCS). n.s.: non significant. *: significant, $p < 0.05$.

<i>Exotic in ONT</i>				
Treatment	MS	F-table values	F-ratio	
Year	0.151	F 0.05(1),1,1=161.0	1.385	n.s.
Burn	0.109	F 0.05(1),1,1=161.0	15.571	n.s.
Density	0.007	F 0.05(1),1,1=161.0	1.167	n.s.
Disking	0.006	F 0.05(1),1,28=4.20	0.063	n.s.
Error	0.095			
<i>Exotic in RCS</i>				
Treatment				
Year	0.187	F 0.05(1),1,1=161.0	187.000	*(p < 0.05)
Burn	0.001	F 0.05(1),1,1=161.0	0.059	ns
Density	0.017	F 0.05(1),1,1=161.0	2.125	ns
Disking	0.008	F 0.05(1),1,28=4.20	0.012	ns
Error	0.67			

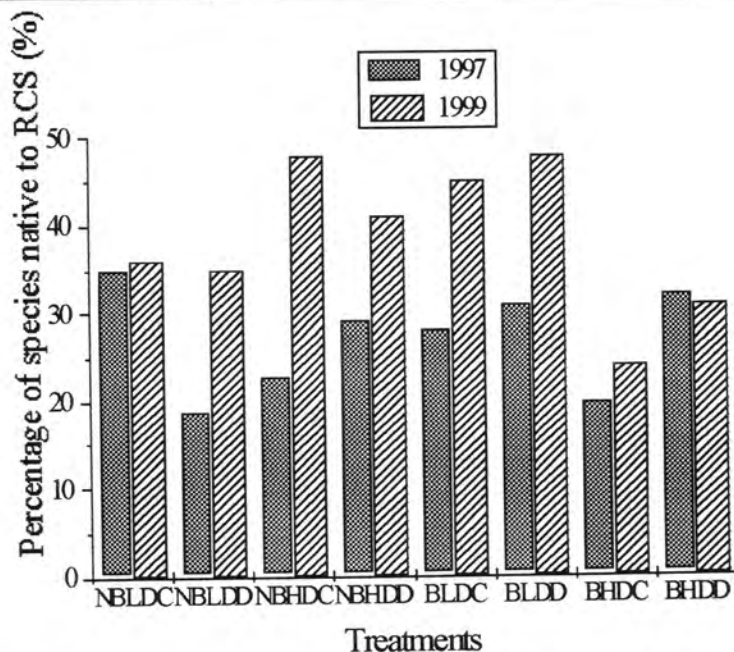


Fig. 16 Percentage of species native to RCS in 1997 and 1999 in the De Laurier Field restoration site.

There was no significant difference among treatments in the number of species native to RCS. More importantly, there was an overall increase in the RCS native species richness from 1997 to 1999 (Fig. 16). Species in this category are listed in Appendix 2.

The next step was to investigate the plant community composition using a multivariate approach, in which we performed a Detrended Correspondence Analysis (DCA) on the 1997 and 1999 plant species data sets (Fig.17).

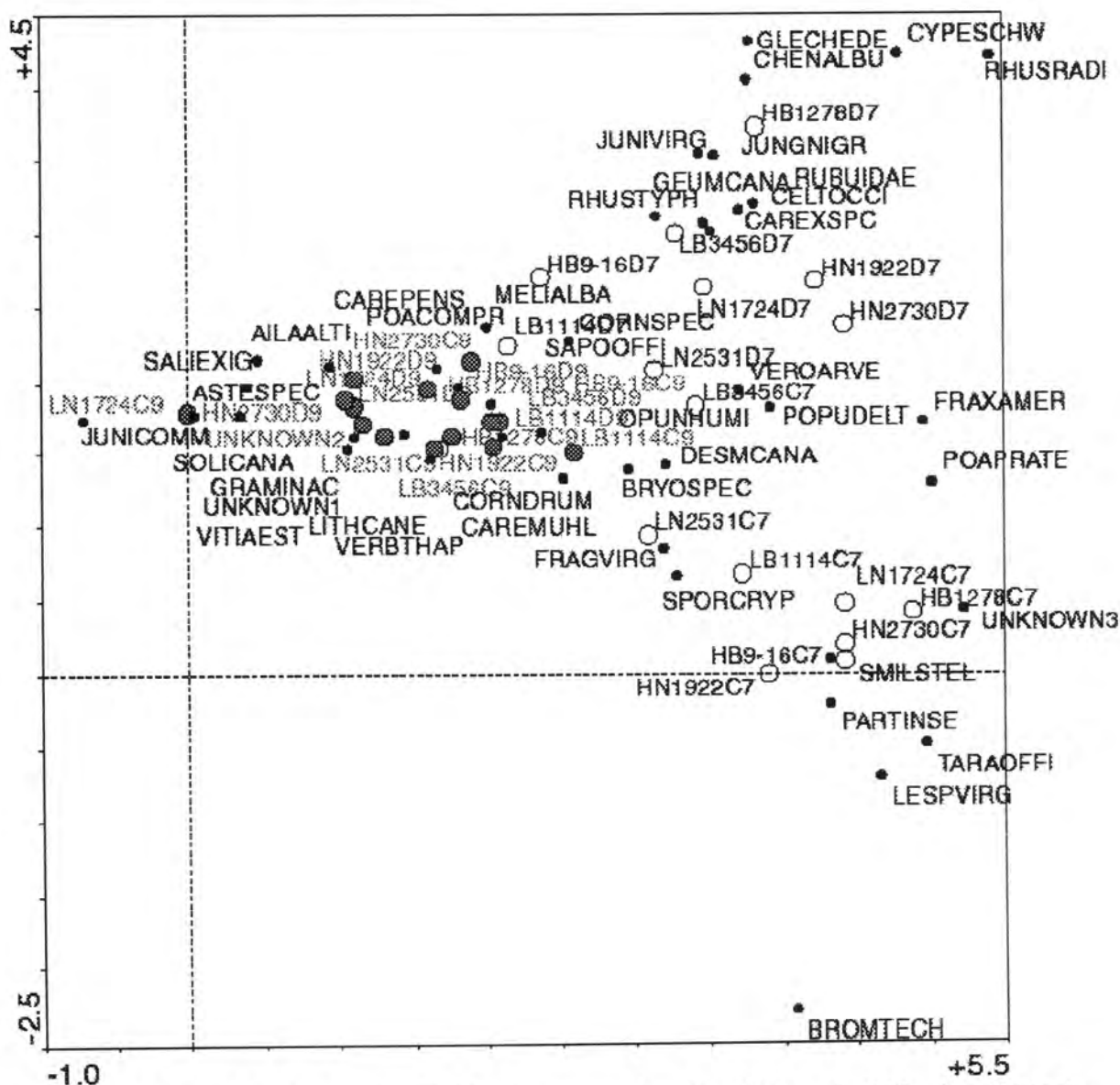


Fig. 17 DCA on the DeLaurier Field plant cover data for 1997 and 1999. Small black circles represent the species, while bigger ones represent the plots. The 1997 plots are in white and the 1999 plots are in grey.

Overall, in 1999 the species which characterized the plots at the DeLaurier Field were *Melilotus alba*, *Carex pensylvanica*, *Helianthus altissima*, *Salix esigua*, *Juniperus communis*, *Solidago canadensis*, *Vitis aestivalis*, *Cornus drummondii* and *Opuntia humifusa*, all of which are found on the left side of the diagram. In 1999, the treatment plots had moved closer together which mean that they had become more similar in plant composition than they were in 1997. In 1997 the sites were more spread out, indicating that the plant community was more heterogeneous. In particular, species as *Taraxacum officinalis*, *Poa pratensis*, *Carex* spp., *Populus deltoides*, and *Smilacina stellata* had greater abundance in 1997. The mean total percent cover of species native to Red Cedar Savanna was 13.5% in 1997, and 14% in 1999, indicating that while native species richness increased, the total cover did not change.

Nature Reserve

The following histogram shows the proportion of the total number of plant species categorized as exotic (Fig. 18). The species were categorized as for the DeLaurier Field, as exotic or native, at two levels, the RCS community and the province of Ontario. There was no significant difference either among years or among treatments in the number of exotic species.

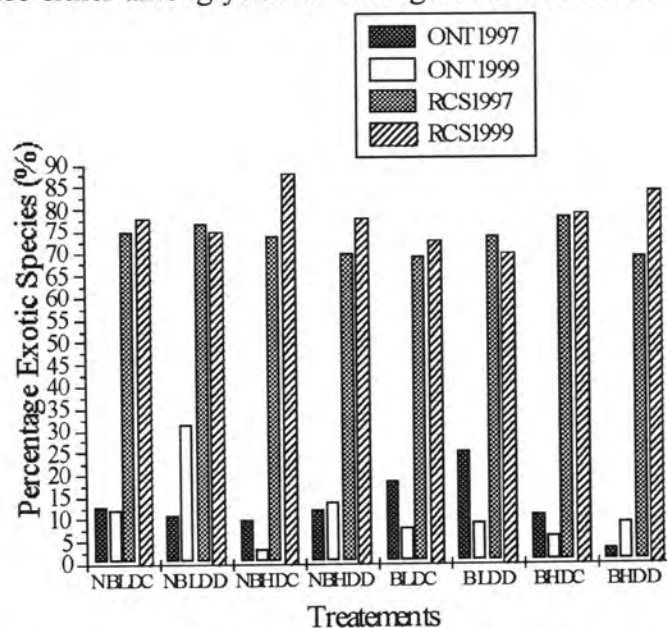


Fig. 18 Percentage of species exotic to RCS and to Ontario in 1997 and 1999 in the Nature Reserve restoration site

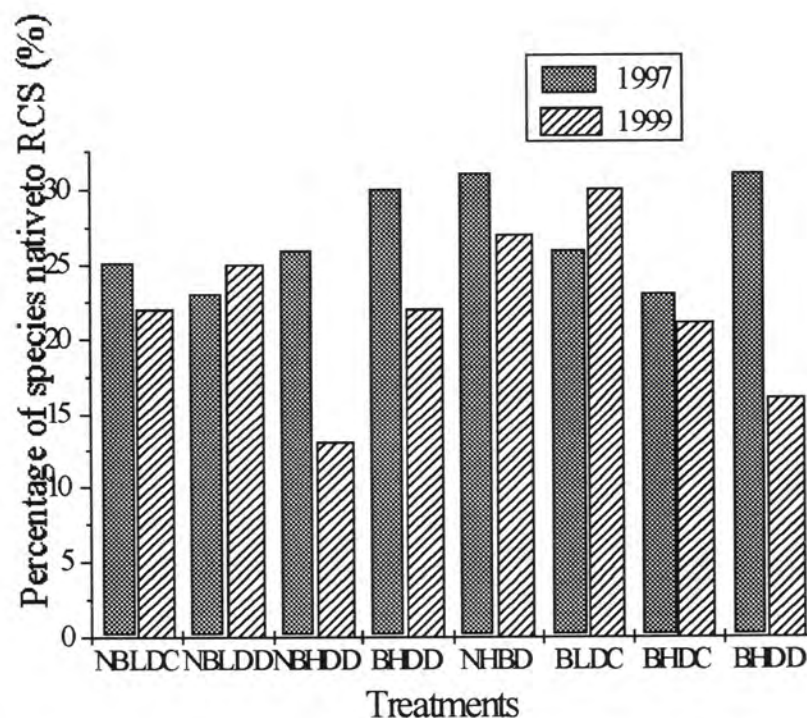


Fig. 19 Percentage of species native to RCS in 1997 and 1999 in the Nature Reserve restoration site

As shown in Table 11, none of the treatments had a significant effect on the percentage of species exotic to either RCS or Ontario and neither was there a year effect. Overall, there was decrease in species native to RCS (Fig. 19).

Table 11 Nature Reserve. ANOVA on the percentage of species exotic relative to Ontario (ONT) and red cedar savanna (RCS) n.s.: non significant. *: significant, $p < 0.05$.

<i>Exotic in ONT</i>				
Treatment	MS	F-table values	F-ratio	
Year	0.002	F 0.05(1),1,1=161.0	0.667	n.s.
Burn	0.003	F 0.05(1),1,1=161.0	0.065	n.s.
Density	0.046	F 0.05(1),1,1=161.0	9.2	n.s.
Disking	0.005	F 0.05(1),1,28=4.20	0.2	n.s.
Error	0.025			
<i>Exotic in RCS</i>				
Treatment	MS	F-table values	F-ratio	
Year	0.053	F 0.05(1),1,1=161.0	4.818	n.s.
Burn	0.011	F 0.05(1),1,1=161.0	0.393	n.s.
Density	0.028	F 0.05(1),1,1=161.0	7.000	n.s.
Disking	0.004	F 0.05(1),1,28=4.20	0.005	n.s.
Error	0.863			

Finally, we performed a DCA on the percentage cover data for the Nature Reserve in 1997 and 1999, shown in Figures 20 and 21. Due to overcrowded ordination diagrams, we separated the species diagram (Fig. 21) and the plot diagram (Fig. 20). In 1999 the sites were more spread out than in 1997. The 1997 sites tended to cluster all together at the left side of the diagram while the 1999 sites are spread along the 2nd axis. The low Red Cedar density plots in 1999 are found at the more extreme right end of the diagram, fairly separate from the high Red Cedar density plots, which are in the middle. The burned and disking treatment plots did not separate out (Fig. 20). This is an opposite trend from that observed in the DeLaurier Field site.

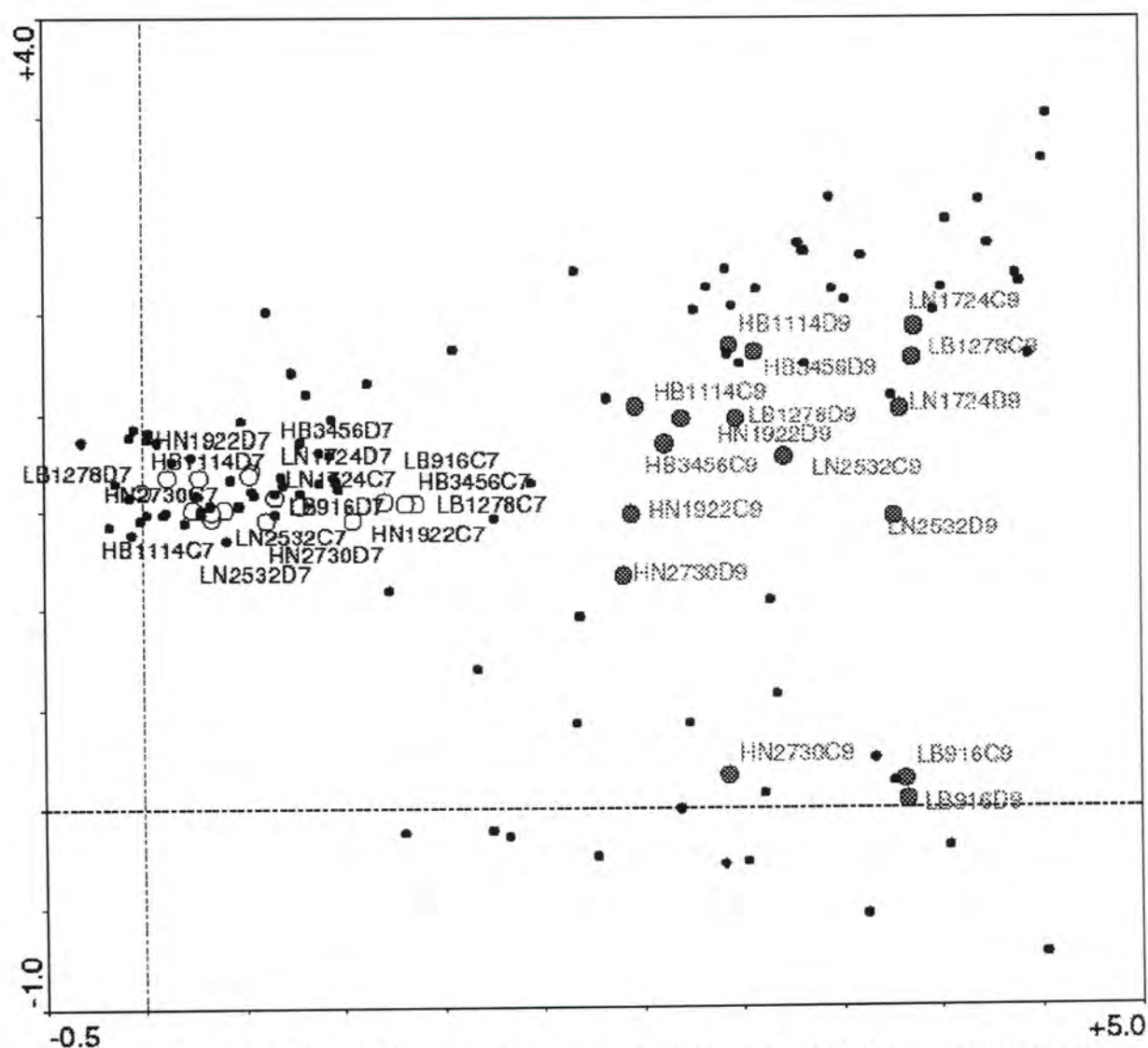


Fig. 20 DCA on the Nature Reserve plant cover for 1997 and 1999 (sites only labeled). Species are small black circles; sites are larger white (1997) and grey (1999) circles.

In 1997 the dominant species were *Carex pensylvanica**, *Taraxacum officinalis*, *Anemone canadensis*, *Agrimonia rostellata**, *Celtis occidentalis**, while in 1999 *Solidago canadensis**, *Desmodium canadensis**, *D. canescens**, *Eupatorium perfoliatum** (*:species native to RCS plant community) increased (Fig. 21). Thus, there was been a qualitative change in composition. The total percent cover of native species in 1997 was 48% and 10% in 1999.

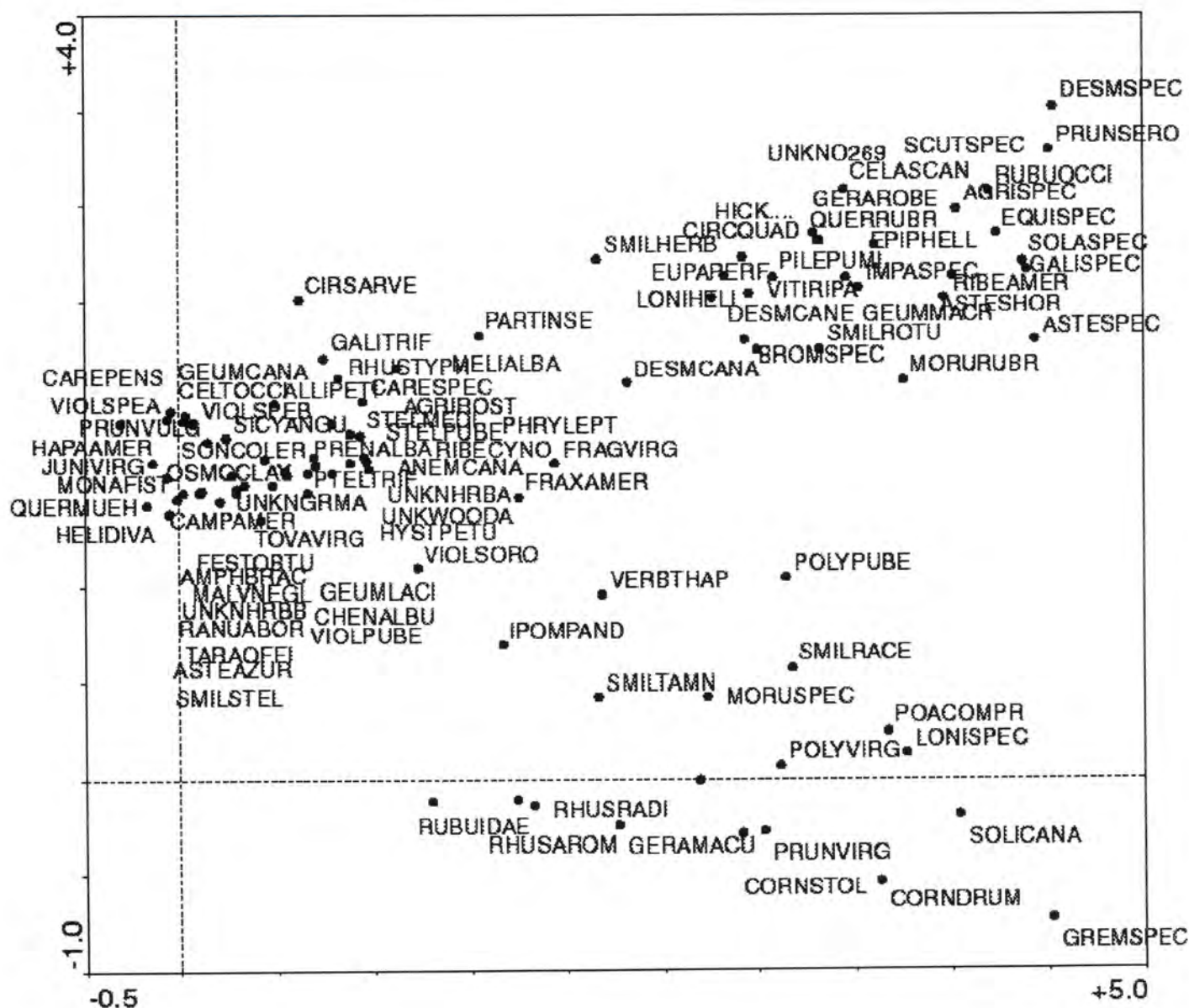


Fig. 21 DCA on the Nature Reserve plant cover for 1997 and 1999 (species only labeled)

Discussion

Pinery Provincial Park

In both habitat types, Black and Black – White Oak Savanna, we observed a shift in plant community composition from 1994 and 1999. The grazed controls behaved similarly to the deer exclosures in term of species composition, which we interpret as a direct effect of the deer reduction and burn, applied in the preceding years. The 1994 community was dominated by species that are more grazing tolerant (e.g. *Aquilegia canadensis*) (Pearl et al. 1995) than the ones found in 1999 (e.g. *Geranium maculatum* in BS, and *Hamamelis virginiana* in BWS). This seems to indicate that the deer exclusion and herd reduction have created sites where, because of the lower grazing pressure, grazing-sensitive species have been able to become established. We do not know when and how future culls should be carried out, but it seems that the maintenance of the present low deer density will contribute to an improvement in the understorey plant community composition. The DCA of the Black – White Oak Savanna sites in 1999 shows a greater shift from 1994 than the one of Black Oak Savanna. This result is consistent with the results for shrub density, where we observed a decrease in density in BS sites and an increase in density at BWS sites. These data suggest that deer use of these two communities has differed, with increased grazing and browsing in the BS areas compared to the BWS areas.

The tree density did not show any significant difference between communities and years, but this could be related to the need for a longer time frame to detect changes in tree density compared with shrub density. Shrubs are likely to be more immediately affected by changes in deer grazing pressure. During the survey we observed many dead shrubs without leaves, which suggests that the deer have been a major cause of shrub mortality. The relative tree and shrub density data show that in both BS and BWS the shrub species richness increased in 1999 compared with 1994, indicating another beneficial effect of the deer cull and burn treatments. For example, the presence was noted in 1999 of *Amelanchier sp* and *Juniperus virginiana* in BS, and *Rubus occidentalis* in BWS none of which were not recorded in 1994.

Point Pelee National Park

The different burning, tree density and disking treatments did not have an overall long-term effect on the plant community. The only significant change was in the percentage of exotic species in the DeLaurier Field, where we observed an increase in native RCS species. No significant effects were recorded in Nature Reserve. The DCAs were different for the two sites. In DeLaurier Field, the DCA suggests that the treatments have made the plots more homogenous in terms of plant community composition. The plots are closer together suggesting that the treatments have favoured the germination of the same species in all plots. This was confirmed by the fact that there was not a distinct effect of each treatment as shown in the Nested ANOVA analysis. Probably the burning and the disking have worked as expected, in order to create better conditions for seed germination, but in Nature Reserve, these treatments have not improved the chances of RCS native species germination. In the Nature Reserve we found the opposite trend to the De Laurier Field. The 1999 plots appear to be more different to each other than they were in 1997, meaning that the plots have diversified in plant species composition, but in a random way that did not correspond to any of the treatments applied. This diversification also includes the presence of species that were not recorded in 1997 and the loss of some of the species recorded in 1997. In Nature Reserve we hypothesize that the treatments were applied too late, and that the seed bank had become dominated by exotic species. In contrast, the increase of native species in 1999 at DeLaurier Field, was likely due to a reasonable RCS seed bank becoming established.

We did not have data on the RCS native species seed bank (which is now analyzed and available in Falkenberg 2000), but our data suggested that the seed bank is probably in poor condition especially in NR. In addition, the burning of Red Cedar Savanna has been delayed to the point, where, in the absence of deer, there has been a huge amount of shrubby growth over the last 3-4 years. This has likely reduced the effectiveness of the recovery efforts there. Whether this would happen in Pinery remains to be seen. There is much that we do not know about the development and directionality of change of Oak Savanna communities. The situation in Rondeau Provincial Park suggests that in the absence of deer, some of the oak Savanna habitats have become compromised (Natvik, pers. comm) by succession.

Conclusion and Management Recommendations

Pinery Provincial Park

We support the burns proposed for spring 2000 and future. We are currently in a time-lag - the effects of deer herd reductions are operating: 1) in a patchy way 2) on different time scales in different parts of the park.

1) We need to burn in order to get information on the seed bank for which germination will be triggered. The nature of the seed bank will indicate whether reintroduction (by undetermined, as yet, means are needed).

2) Whether the deer are at a low enough level to allow recovery we do not know this until we burn because their impact on tree, shrub and unburned plant community composition has now entered this lag phase in which large changes are going to take 4-10 years to show. We do not have this time if we want to take advantage of the existing seed bank.

We also suggest that a direct evaluation of the seed bank should also be done next summer.

We are concerned that the accepted deer carrying capacities proposed for allowing habitat recovery and regeneration in Pinery, may actually be too high!!! The reason for this is that these capacities are based in part on what we know about regeneration in relatively unstressed forests. It may be the case that in highly stressed habitats that even lower carrying capacities are required. In other words - the appropriate carrying capacity is likely to be time dependent. At the same time, we are trading off the effects of deer and time needed for recovery, against the inexorable process of plant succession. The only way to sort these problems out is by intervention and data collection. We now have the databases to be able to compare shifts in plant community composition. It is our opinion that on the whole, burning should not be delayed. We would like to monitor deer habitat use on a fine scale. If there is evidence of deer congregating in burned areas, then this would have to feed in to deer management decisions, but we need to know this sooner rather than later.

Finally, our biggest challenge is to undertake another browse survey since this is the best handle on habitat recovery (but the most tedious and hateful one to do). We propose to do one this Fall 2000. This would also allow us to see just how patchy deer

use has become in the park as our data suggest that the deer are using differently the two habitat (BS and BWS).

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It seems reasonable at this point to recommend the reintroduction of species of particular interest to the park managers. From the DCA result of this report we could easily identify the chosen species and in which condition they are now. This was also suggested by Falkenberg (2000).

References

- Falkenberg, N. 2000. Recovery of a savanna habitat in Point Pelee National Park, Southwestern Ontario. M.Sc. Thesis. York University, Toronto.
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Appendix 1

Field Directions to Pinery Provincial Park deer exclosures (June 1999)

Black Oak Savanna

BS 1.1: Go to Visitor Center (VC) parking lot. Before the wooden stare walkway, which leads you to the VC, in your left there is a big board that shows the map of the Cedar trail. From the Cedar trail 's board, walk in the trail for 81 paces (around 81 m) and stop. You may be able to see the exclosure from. At this point you should be close to a little chicken wire exclosure which is located in your left on the trail. Then walk 50 paces NW in your right.

BS 4.1: Because there are two Cedars trail signs (boards), you have to be careful and note as below!

1. It is a small sign of the Cedar trail located in the main road (on the way to VC). It is located at the opposite side of the road and opposite to the VC sign (the big one at the entrance of the VC parking lot).
2. Is the one you found going for BS 1.1 that shows a big map of the Cedar trail.

To reach BS 4.1 you have to go to the 1st sign. Then walk 38 paces (around 38m) at East. The exclosure is right after the sandy ridge.

Note: June 19,1999 the door of the exclosure was found open.

BS 5.1: Go to group campgrounds number 1 and follow the road, which leads you to the camping ground. When you arrive at the washroom you will see the parking lot in front of you. At the end of the parking lot there are two yellow posts. Those posts mark the beginning of a trail. Follow the trail for 155 paces and then you should find an orange flag in your right. From the flag walk 50-60 degrees and you will reach the exclosure in less then 100 paces.

Note: The control is at 3 m from the NW corner of the exclosure in the NW direction. The control flag is in the SE corner of the control quadrat. One side of the quadrat is at NW, the other at SW.

One blueberry☺ in the exclosure quadrat!

BS 6.1: Go to Park Shop, then walk towards wood yard along main road. The orange flag is located between a buried cable box and a 4*4 inches post. Exactly at 12 paces before the buried

cable, which is in the W side of the main road and at 41 paces from the post which is in the E side of the main road. (Not go after yellow sign in main road, which say: Hidden intersection)

Ones you have reached the flag, which is a sort of gap area, enter the forest for 144 paces in the NE direction, over the ridge. Then you will arrive at an other 4*4 inches post, which say 9 Km. From this point you should be able to see the exclosure at 110 degrees walking 37 paces.

Note: One pin was found in S direction, around 1,5 m from the exclosure.

BS 7.1: Go to VC parking lot, then follow the Cedar trail. Turn left at the 1st intersection to reach the trail post 7. Then walk 34 paces backward and enter the forest at 220 degrees for 298 paces.

Note: Two yellow pins were found inside the exclosure. The exclosure door was found open. The control quadrate is located at NW.

BS 8.1: Walk 150 paces from camp group camp 3 at your right from the last yellow post.

Note: exclosure was found open . The control is at SW direction from the SW-W corner of the exclosure .

BS 9.1: Go to picnic area entrance 9 and start form the stop sign (at NE-E) along main road. Walk from the stop sign 19m towards VC in main road, in the only way possible by car now. At this point you should find the flag in the other side of the road. Then enter forest at 135 degrees for 300 paces

Note: The flags on the road and at the exclosure are named erroneously BS 8.1. In August you should definitively change the flags with the right name BS 9.1. The control is at 3 m from the NE corner of the exclosure in the SE direction. The sides of the quadrate are at SW and SE.

BS 9-5.1: This exclosure is located between BS 5.1 and BS 9.1.Go to picnic area exit 7. You will see the stop sign. Cross the street at the sign you should be at the South side of the road now. Then walk at 120 degrees for 130-150 paces to the exclosure.

Note: The control quadrate is located Eastward at 3 m from the NE corner of the exclosure.

BS 10.1: Go to the entrance of Nipissing trail. Walk on the trail starting on the right, keep right until you arrive to a wooden walk step which leads you down from the send dune. Go at the end of it and form there you should see the enclosure in your left. Walk 55 paces SE to get there.

Note: We sampled the exclosures quadrates at 10:45 am and it was the only part of the exclosure exposed to sunlight. The other parts were under shadow. This because of the leaves of an individual of *Vitis* sp. with roots outside of the exclosure. It was also the one with highest percentage cover of bare ground

BS 10.2: Walk 150 paces from the beginning of the hand wooden trail located after the wooden walk step that did lead you to BS 10.1.

Black-White Oak Savannah

BWS 1.1: Now the road is only one way (for car) therefore it is not possible to drive back from the North Bridge. If you have a car then you will need to park it close to the North Bridge Then walk back from the bridge 500 paces in the SW direction. There is a noticeable car pull off on your right (North side of the road). Opposite this is a 10cm*10cm post about 6' height in the other side of the road. From the post walk 16 paces NE backwards, towards the bridge along main road. At this point enter the forest and walk SE for 100 paces.

BWS 1.2: From the orange flag on road of BWS 1.1 walk 168 paces along main road in the opposite direction of the bridge. You will find the flag for this exclosure. At this point enter the forest and walk 70 paces SE.

Note: We saw a piece of orange flag outside of the exclosure in the NE direction. The control is located at 3 m from the NW corner of the exclosure in the SE direction. One side is at SE the other at NE??

BWS 1.3: From flag on road of BWS 1.2 walk 176 paces along main road. You will see the flag for this exclosure. Then walk 62 paces SE from the flag.

Note: The control is at SW from the NW corner of the exclosure. The flag of the control quadrate represent his NE corner.

BWS 2.1: Go to Pinery Park main entrance. In the left side (exit) of it there is the stop sign for the people coming out of the park. From the sign walk along high way 21. Count the posts with reflector glass along the road, when you arrive at the 20th (including the first and last) stop, you should see the flag. If you prefer, the flag is also located at 38 paces from the second yellow sign

along road that say: Provincial Park Boundary. Enter the forest from the 20th post and walk at NW for 90 paces.

Note: There is a sand ridge before the exclosure.

BWS 2.2: This exclosure is located at 80 paces in the NW direction from NW corner of BWS 2.1.

Note: An individual of *Vitis* sp. with roots outside the exclosure has covered the top of the exclosure.

BWS 3.1: Go to the Pinery Park exit. Then walk 75 paces or count 4 posts (included first and last) with reflector glass along highway 21. From the flag walk 168 paces (150 m) at 335 degrees.

Note: The long trunk of a tree is lying on one side of the exclosure. The control is located in the W direction from the NW corner of the exclosure. One side is in the W direction, the other at N.

BWS 3.2: The exclosure is located at 175 paces at 335 degrees from main road. We found it after BWS 3.3, so if you go to BWS 3.3 first you can walk 75 paces SW and find BWS 3.2.

Note: The control is in the NE direction from the exclosure.

BWS 3.3: From flag of BWS 3.1 walk 225 paces backward toward the park exit (counting almost 9 glass reflector posts). Enter the forest at 335 degrees for 155 paces.

BWS 4.1: Go to the trailer sanitation station from the two water pump walk 100m in the north-east direction.

BWS 4.2: From BWS 4.1 walk at least 100 paces at 30 degrees. The exclosure is after a sand ridge.

Note: 1 paces is assumed to be more or less equal to 1 m.

Appendix 2

List of Species present in Point Pelee National Park in 1997-1999

(ONT: Status in Ontario; Status: RCS in Red Cedar Savanna; n: native, e: exotic)

Species Scientific Name	ONT	RCS	DF 1997	DF 1999	NR 1997	NR 1999
Agrimonia rostellata	n	n			*	*
Agrimonia sp.	e	e				*
Ailanthus altissima	e	e		*		*
Allaria petiolata	e	e			*	*
Amphicarpa bracteata	n	n	*		*	
Anemone americana	n	e?			*	
Anemone canadensis	n	n			*	
Arabis lyrata	n	n			*	
Asparagus officinalis	e	e	*			
Aster azureus	n	e			*	
Aster shortii	n	n				*
Aster sp.	n	n		*		*
Bromus sp.	n	e				*
Bromus tectorum	e	e	*			
Bryophyta	n	e		*		*
Campanula americana	n	e			*	
Carex muhlenbergii	n	n	*	*	*	*
Carex pensylvanica	n	n	*	*		
Carex pensylvanica	n	n				*
Carex sp.	n	n			*	*
Celastrus scandens	n	e				*
Celtis occidentalis	n	n	*		*	
Chenopodium album	n	e	*		*	
Circaea quadrisulcata	n	e			*	*
Cirsium arvense	e	e			*	*
Cornus drummondii	n	e	*	*	*	*
Cornus sp.	n	n				*
Cornus stolonifera	n	n				*
Cyperus schweinitzii	n	n	*			
Desmodium canadense	n	n			*	*
Desmodium canescens	n	n				*
Desmodium sp.	n	n				*
Elymus hystrix	n	e			*	
Epipactis helleborine	e	e				*
Equisetum hyemale	n	e			*	*

Equisetum sp.	n	e				*
Eupatorium perfoliatum	n	n				*
Festuca obtusa	n	n			*	
Fragaria virginiana	n	e	*	*	*	*
Fraxinus americana	n	e	*		*	*
Galium sp.	n	e				*
Galium triflorum	n	e			*	*
Geranium maculatum	n	e			*	*
Geranium robertianum	n	e				*
Geum canadense	n	e	*	*		*
Geum laciniatum	n	e			*	
Geum macrophyllum	n	e				*
Glechoma hederacea	e	e	*			
Gramineae sp.	n	n		*	*	*
Helianthus divaricatus	n	e			*	
Hickory ?	?	?				*
Impatiens sp.	n	e				*
Ipomea pandurata	n	n			*	*
Juglans nigra	n	n	*			
Juniperus communis	n	n		*?		*
Juniperus virginiana	n	n	*		*	
Lespedeza virginica	n	e	*			
Lithospermum canescens	n	e		*		*
Lonicera helian	e	e				*
Lonicera sp.	n	e				*
Malva neglecta	e	e			*	
Melilotus alba	e	e		*	*	*
Monarda fistulosa	n	n			*	
Morus rubra	n	e				*
Morus sp.	n	e				*
Opuntia humifusa	n	n	*	*		*
Osmorhiza claytoni	n	e			*	
Parthenocissus inserta	n	e	*		*	*
Phleum sp.	n	e				*
Phryma leptostachya	n	e			*	*
Pilea pumila	n	e				*
Poa compressa	n	e	*	*	*	*
Poa pratensis	n	e	*			
Poa pratensis	n	e				*
Polygonatum pubescens	n	e				*

Polygonum virginianum	e	e				*
Populus deltoides	n	e?	*			
Prenanthes alba	n	n			*	
Prunus serotina	n	e				*
Prunus virginiana	n	e			*	*
Ptelea trifoliata	n	n			*	
Quercus muehlenbergii	n	n			*	
Quercus rubra	n	e				*
Ranunculus abortivus	n	e			*	
Rhus aromatica	n	n			*	*
Rhus radicans	n	e	*		*	*
Rhus typhina	n	n	*	*	*	*
Ribes americanum	n	e				*
Ribes cynosbatii	n	e	*		*	*
Rosa blanda	n	e				*
Rubus Idaeus	n	e	*		*	*
Rubus occidentalis	n	e				*
Salix bebbiana	n	e				*
Salix exigua	n	n	*	*		*
Sambucus canadensis	n	e				*
Saponaria officinalis	e	e	*	*		*
Sassifras albidum	n	e				*
Scutellaria sp.	n	e				*
Sicyos angulatus	n	e?			*	
Smilacina racemosa	n	e				*
Smilacina stellata	n	e	*		*	*
Smilax herbacea	n	e			*	
Smilax rotundifolia	n	e				*
Smilax tamnoides	n	e			*	*
Solidago canadensis	n	n	*	*	*	*
Sonchus oleraceus	e	e			*	
Sporobolus cryptandrus	n	n	*	*		*
Stellaria media	e	e			*	
Stellaria pubera	n	e			*	
Taraxacum officinale	e	e	*	*	*	*
Tovara virginiana	n	e			*	
Tragopogon pratensis	e	e	*			
Urtica dioica	e	e				*
Verbascum thapsus	e	e	*	*	*	*
Veronica arvensis	e	e	*			

Viburnum	n	e				*
Viola sororia	n	e			*	*
Vitis aestivalis	n	e	*	*		*
Vitis riparia	n	e			*	
Vitis sp.	n	e				*

List of Species present in BS and BWS in Pinery Provincial Park in 1994 and 1999

Note *: present

Scientific Species Name	BS 1994	BS 1999	BWS 1994	BWS 1999
Amelanchier sp.				*
Aquilegia canadensis		*	*	*
Aster sp.			*	*
Blephilia hirsuta				*
Carex pensylvanica		*		*
Compositae				*
Cornus alternifolia				*
Cornus rugosa		*		*
Cornus sp.	*			
Euphorbia esula	*		*	
Fragaria virginiana		*		*
Fragaria sp.	*		*	
Fraxinus americana				*
Galium circaezans	*		*	*
Galium pilosum	*	*	*	*
Galium triflorum			*	
Gaultheria hispidula	*		*	
Gaultheria procumbens	*		*	
Geranium maculatum		*	*	*
Gramineae	*	*	*	*
Hamamelis virginiana			*	*
Helianthus divaricatus	*	*	*	*
Helianthus sp.	*			
Hieracium sp.	*		*	*
Impatiens sp.	*			
Juniperus communis		*		*
Juniperus virginiana		*		*
Lespedeza hirta				*
Lithospermum canescens		*		*
Lonicera dioica		*		*
Lonicera sp.	*			
Maianthemum canadense	*	*	*	*

Marrubium vulgare		*		*
Melampyrum lineare	*		*	
Melampyrum lineare		*		*
Oryzopsis sp.		*		*
Pedicularis canadensis		*	*	*
Poa compressa				*
Poa pratensis		*		*
Polygala polygama		*		*
Prunella vulgaris	*		*	
Prunus serotina	*	*	*	*
Prunus sp.	*		*	
Prunus virginiana		*	*	*
Pteridium aquilinum	*	*	*	*
Quercus alba	*	*	*	*
Quercus muehlenbergii	*			
Quercus pinoides	*	*		*
Quercus rubra		*	*	*
Quercus sp.	*			*
Quercus velutina	*	*		*
Rhus aromatica	*	*	*	*
Rhus radicans	*	*	*	*
Rubus (alleg or canad)	*		*	
Rubus idaeus	*			
Rubus sp.	*		*	
Rubus occidentalis		*		*
Rudbeckia hirta	*			
Rumex sp.	*		*	
Sanicula marilandica			*	
Sassifras albidum			*	*
Senecio ?				*
Senecio obovatus	*	*	*	*
Senecio pauperculus	*	*	*	*
Smilacina racemosa	*	*	*	*
Symphoricapos albus		*		*
Solidago sp.			*	
Taraxacum sp.	*		*	
Vaccinium sp.	*		*	
Viola sp.	*			
Vaccinium sp.		*		*
Vinca minor	*			
Vitis aestivalis		*		*
Vitis sp.	*		*	
Unknown tot	*	*	*	*